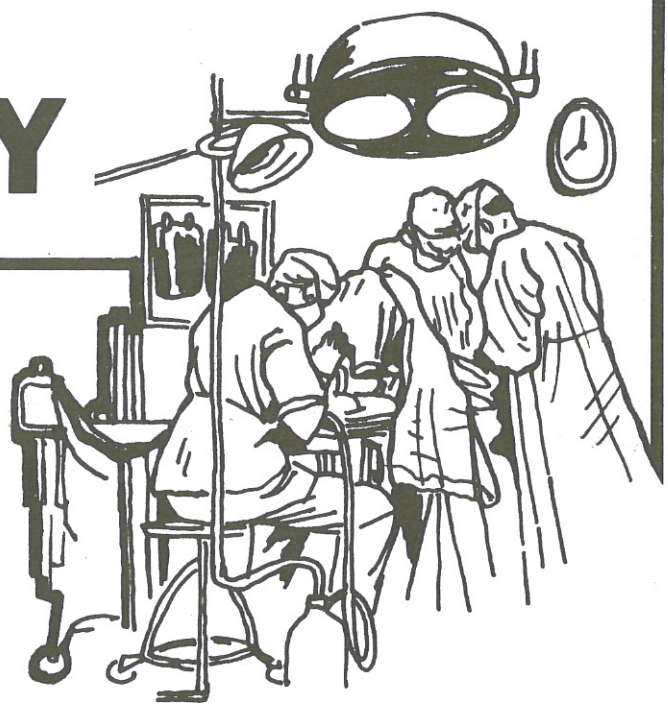
COMMANDER IN CHIEF PACIFIC

FIFTH CONFERENCE ON

WAR SURGERY



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Subj: Commander in Chief Pacific Fifth Conference on War Surgery

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Encl: (1) Proceedings of CINCPAC Fifth Conference on War Surgery

1. The fifth of the series of conferences on war surgery sponsored by CINCPAC was announced by reference (a) and held 29 March - 2 April 1971. The largest group of surgeons to participate in any of these conferences met and further refined the professional surgical guidance promulgated by previous conferences (enclosure (1)).

2. Surgeons from the three geographic echelons of hospitals where extensively wounded casualties receive care exchanged information concerning results and complications attendant upon required surgical procedures. All conferees are actively engaged in the surgical care of Vietnam casualties.

3. The professional content of this document is the consensus position of the participating surgeons. It is not intended that the document meet commercial publishing standards; instead, the effort has been to produce a timely document for the use of the working surgeons.

4. These proceedings are made available to the Surgeons General, CINCPAC Component Command Surgeons and the MACV Surgeon for use as appropriate in furthering the professional care of casualties.

Frank B. Voris M.D.

FRANK B. VORIS
Surgeon

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ATTENDEES

VORIS, F. B., RADM, USN, Surgeon, CINCPAC, FPO San Francisco 96610

GEIB, P. O., CAPT, USN, Chairman, USNH, Yokosuka, FPO Seattle 98765
HENDERSON, J. A., COL, USAF, Vice Chairman, HQ, 5th Air Force
NOEL, P. J., COL, USA, Vice Chairman, HQ, USARVN, APO San Francisco 96384
ALLEN, E. C., CAPT, USN, Oral Surgery, USN Dental Clinic, FPO Seattle 98765
FITCHETT, V. H., CAPT, USN, General Surgery, USNH, Oakland, California
HAMILTON, W. W., CAPT, USN, Neuro Surgery, USS SANCTUARY AH-17, FPO San Francisco 96601
NELSON, T. G., COL, USA, General Surgery, Tripler Army Medical Center, APO San Francisco 96438
WALTON, S., COL, USA, Orthopedic Surgery, Tripler Army Medical Center, APO San Francisco 96438
WEIGEL, J. W., COL, USA, Urology, USAH, APO 96343

AH-TYE, P., CDR, USN, Thoracic Surgery, USNH, FPO Seattle 98765
BRESLAU, R., LCOL, USAF, Vascular Surgery, USAFH, APO 96323
BRODHEAD, C. L., CDR, USN, General Surgery, USNH, FPO Seattle 98765
CONNOLE, P. W., CDR, USN, Oral Surgery, COMNAVFORV, FPO San Francisco 96626
CROSS, G. H., CDR, USN, General Surgery, USNH, FPO Seattle 98765
DAVIS, D. R., CDR, USN, Anesthesiology, USNH, FPO Seattle 98765
EBERHARD, F., LCOL, USA, Orthopedic Surgery, 85th Evac Hosp., APO San Francisco 96238
ELLIOT, W. A., CDR, USN, Orthopedic Surgery, 1st Med Bn., 1st Mar Div., FMF, FPO SF 96602
FACKLER, M. L., CDR, USN, General Surgery, USNH, FPO Seattle 98765
GEER, T., LCOL, USA, General Surgery, 27th Surgical Hosp., APO SF 96325
GEORGE, H. C., LCOL, USAF, Orthopedic Surgery, 483rd USAF Hospital, APO SF 96326
HOLT, R. S., LCOL, USAF, Neuro Surgery, USAFH, Clark, APO 96274
HIX, W. R., CDR, USN, Thoracic Surgery, USS SANCTUARY AH-17, FPO San Francisco 96601
JOHNSON, L. W., LCOL, USAF, Aerospace Medicine, 9th Aeromedevac Group, APO 96274
LUNG, J., LCOL, USA, General Surgery, USAH, APO 96331
MEREDITH, R. C., CDR, USN, Neuro Surgery, USNH, FPO Seattle 98765
ROBERTS, S., LCOL, USA, Surgical Consultant, USARVN, APO 96375
STUCKER, F. J., CDR, USN, ENT Surgery, USNH, FPO Seattle 98765
WEBER, D. M., CDR, USN, Internal Medicine, USNH, FPO Seattle 98765
WILLIAMSON, H. G., LCOL, USA, Orthopedic Surgery, USAH, APO 96343

BOWEN, T., MAJ, USA, General Surgery, 93rd Evac Hosp., APO 96491
BUHROW, W. L., MAJ, USA, General Surgery, USAH, APO 96343
CARSPECKAN, H. H., MAJ, USA, Burns, USAH, APO 96343
CHRISTY, J. D., MAJ, USA, General Surgery, USAH, APO 96343
CROASDAILE, D. L., LCDR, USN, ENT Surgery, USNH, FPO Seattle 98765
COLEMAN, D. L., MAJ, USAF, Aerospace Medicine, CINCPAC, FPO San Francisco 96610
FRANK, W. E., MAJ, USAF, Orthopedic Surgery, USAFH, APO 96323
LOONEY, G., LCDR, USN, General Surgery, 1st Med Bn., 1st Mar Div., FMF, FPO SF 96602
MAGOUN, T., MAJ, USA, General Surgery, USAH, APO 96343
MEAD, C., MAJ, USA, Neuro Surgery, 24th Evac Hosp., APO 96491
ROSENBAUM, B., MAJ, USAF, Internal Medicine, USAFH, APO 96323
THOMPSON, C., MAJ, USAF, General Surgery, 483rd USAF Hospital, APO 96326
WAGNER, K. J., MAJ, USA, Orthopedic Surgery, USAH, APO 96331
WILSON, W., MAJ, USA, General Surgery, USAH APO 96343

OBSERVERS

NIIYA, K., COL, JSDF, Research Div., Self Defense Forces Hospital, Tokyo, Japan
GREGG, R., LCOL, Royal Australian Army Medical Corps, Australia Force Command Fwd., Sagion, RVN
MENDELSON, J. A., LCOL, USA, HQ, MACV, Office of the Surgeon, APO SF 96222

ABBREVIATIONS

APO	Army/Air Post Office
ASMRO	Armed Service Medical Regulating Office (within US)
BUMED	Bureau of Medicine and Surgeon (Navy Surgeon General)
CINCPAC	Commander in Chief Pacific
CINCUSARPAC	Commander in Chief, U. S. Army Pacific
CINCPACFLT	Commander in Chief, U. S. Pacific Fleet
CINCPACAF	Commander in Chief, U. S. Pacific Air Forces
COMUSMACV	Commander, U. S. Military Advisory Command, Vietnam
CONUS	Continental United States
CSAF for AFMSG	Air Force Surgeon General (Correspondence Symbol)
DA OTSG	Department of the Army, Office of the Surgeon General)
FPO	Fleet Post Office
JMRO	Joint Medical Regulating Office (Outside US)
NATO	North Atlantic Treaty Organization
PACOM	Pacific Command
RVN	Republic of Vietnam (South Vietnam)

FORWARD

"Emergency War Surgery", the NATO Handbook, is the basic doctrinal and procedural document of the United States Armed Forces Medical Departments in the accomplishment of the care of combat casualties. This volume, however, cannot be kept current or be rapidly altered to incorporate the findings of the present experiences in the Republic of Vietnam. Also, it is voluminous and so organized that it is time consuming to find specific subjects desired. To gather specific reports of current experiences in the care of casualties from Vietnam and to disseminate this information as widely as possible, the Commander in Chief Pacific has authorized these War Surgery Conferences. The synopses which appear in this report are by no means all inclusive, do not give details of techniques and are intended to furnish the physician and surgeon an overview of those principles which are essential to the attainment of optimum results. Also recorded are those instances where procedures other than those appearing in the NATO Handbook have been found to be more efficacious under the conditions existing in Vietnam. Very importantly, it records some of the principles which have not been well followed in Vietnam and the difficulties which resulted therefrom.

Hopefully, this report will be a firm basis on which the inexperienced combat surgeon can enlarge his knowledge of combat surgery and thereby continue to attain the outstanding results of casualty care already existing in Vietnam. It is recommended that users read the whole manual and not try to use specific portions out of context.

 Limited numbers of additional copies are available from CINCPAC, Attn: Surgeon, FPO San Francisco, California 96610.

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AEROMEDICAL EVACUATION

I. INTRODUCTION

Military surgeons have at their disposal a highly sophisticated, complex, transportation system for rapid patient movement. An understanding of the advantages, limitations and potentialities of this system must be made available to all medical personnel.

The judicious use of aeromedical evacuation markedly reduces the time lapse from injury to definitive care. The decision to evacuate the patient by air to the next level should be made with full knowledge of the flight schedules, lag times, and care available at each stage in the chain of evacuation. Every effort should be made to reduce the workload within the system to the essentials required for good patient care. The flight attendants should not be burdened with unnecessary dressing changes, topical medications, special diet or other procedures which would detract from the care of the more seriously injured patients. THE PHYSICIAN AT THE ORIGINATING HOSPITAL MUST ASSURE HIMSELF THAT THE PATIENT IS READY TO WITHSTAND THE CONTEMPLATED TRIP. Although the patient will be monitored by other physicians enroute, physicians are reminded that patients with oxygenation or pulmonary function problems at ground level may be expected to have increased difficulty at altitude.

Preferably, patients should meet the following minimum criteria for enroute aeromedical evacuation:

1. Stable hematocrit of 35 percent and a hemoglobin of 11 grams percent.
2. Stable vital signs.
3. No active bleeding.
4. Adequate hydration.

II. GENERAL DATA

A. PATIENT MOVEMENT - Under normal conditions, the patient is transferred from the in-country originating medical facility to the in-country Aeromedical Staging Flight (ASF) for evacuation. Usually within 24 hours the patient is moved from the ASF by aircraft to the next echelon. Upon arrival at this next echelon air base he may be transferred directly to an off-shore hospital by surface or by air, or he may be processed through an off-shore ASF (usually within 24 hours) either to the off-shore hospital or directly to the CONUS. Patients destined for onward CONUS movement, who went to off-shore hospitals, are brought after treatment directly to the strategic aeromedical aircraft or are brought again to the off-shore ASF for transfer to the strategic aeromedical aircraft for their onward CONUS movement.

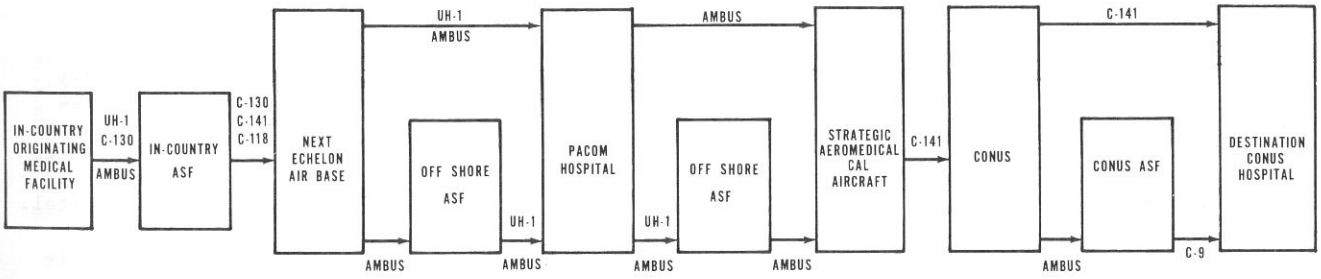


FIG 1

Various portions of the patient's movement by air from injury to final destination will include movement in several types of aircraft. The most usual type of aircraft for the phase of movement is listed first. Other types of aircraft which may be used are included.

	Med EVAC	In-Country Aeromedical Evacuation	Intra-Theater Aeromedical Evacuation	Strategic Aeromedical Evacuation	CONUS Aeromedical Evacuation
	UH-1 "HUEY" CH-47 OH-6 others	C-130 C-7 C-47 C-123 C-118 C-9 (1972)	C-141 C-118 C-130 C-9 (1972)	C-141	C-9 C-141
Representative Flight Times	10-60 min	½-5 hrs	2½-8 hrs	10-16 hrs	1-9 hrs

These times do not include the time between patient arousal for preparation for flight to delivery to the aircraft which is four hours and the time between the end of flight and patient delivery to destination hospital which may be up to three hours.

1. Representative examples of total patient in transit time from definitive care hospital to definitive care hospital which include ASF time are graphically shown as follows for a patient destined from Long Binh RVN to Walter Reed Army Hospital, Washington, D. C.:

a. From in-country hospital to PACOM off-shore hospital (e.g., Long Binh to Camp Zama) 37-40 hours minimum.

b. From PACOM hospital to CONUS hospital (e.g., Camp Zama to Walter Reed) 26 hours minimum.

c. Time in Camp Zama Hospital, 10 hours minimum.

d. From in-country hospital to CONUS hospital, total time enroute, 73-76 hours minimum.

e. For a patient destined for Fort Gordon, Georgia; add to this minimal time an additional 26 hours.

Hence a total of 92-102 hours (four days) will elapse as minimum time for in-country definitive care facility to CONUS destination with optimal travel schedule. Additional days may be added at Remain Over Night (RON) stops if out of phase with aircraft schedules, adding 96-144 hours (four to six days) to this for a total of 8 - 10 days. These are minimum and maximum times enroute, depending on when the patient enters the evacuation system. Surgeons must take this into account when scheduling patients, considering that supportive care only is available enroute. If a shorter time to definitive care is required, the patient should be sent to an off-shore hospital.

Occasionally, where medical urgency dictates for the acutely ill or injured and/or unstable patient and where prior arrangements and coordination have been made, plane-to-plane patient transfers may be made. This procedure is most often seen in the intratheater area, primarily the combat zone. This type of patient movement should be reserved for patient movement over relatively short distances where it is necessary to get the patient to immediate definitive care. In view of the medical and surgical capability that exists in in-country and off-shore PACOM hospitals, and in view of the long times enroute with concomitant patient condition regression that these time lapses cause, plane-to-plane transfers for in-country to CONUS movements are discouraged in favor of definitive enroute patient care by staging through off-shore hospitals.

B. AIRCRAFT - With one exception, the aircraft used in aeromedical evacuation are primarily and basically cargo or freight aircraft designed for hauling cargo or freight. Hence they are normally noisy and dimly lit. Their use in aeromedical evacuation is an adaptation. Medical

supplies and equipment must be brought on board and the interior of the aircraft set up to accomodate patients. The adaptation of these aircraft to patient carrying role, while not the optimum, enables the transport of large numbers of patients with existing aircraft. Consideration of the environment must nevertheless be part of the surgeon's decision on when to Air Evac.

The one exception is the C-9 Nightingale. This is an adaptation to aeromedical evacuation use of the DC-9 used currently by the airlines. Its interior was completely engineered and designed for aeromedical evacuation and includes such features as pressurization, humidity control, cardiac monitoring, sound proofing, better lighting, in addition to the basic aeromedical evacuation accommodations. This aircraft is used only in the CONUS presently but is scheduled to be introduced to the PACOM area in 1972 for use in the in-country and intratheater phases of aeromedical evacuation.

C. INFLIGHT MEDICAL EQUIPMENT - AVAILABLE

STANDARD

Flight Nurse's Medical Kit
Medical Chest (Sterile supplies, restraints, urinals, etc.)
Blanket Pack
Oxygen Kit (Therapeutic type) or Aircraft Oxygen System
Resuscitator (Ambu type)
Suction Unit (Carmody or Pesco) Intermittent only
Linen Pack (Miscellaneous Linens)

SPECIAL

Incubator
Stryker Frame
Collin's Traction Unit
Bird Respirator
Artificial Nose
OB Pack

INFLIGHT MEDICAL EQUIPMENT - NOT AVAILABLE

Continuous Suction
110 Volt, 60 cycle current (except C-9A)
Cardiac monitoring (except C-9A)
Defibrillator (except C-9A)

D. PATIENT REGULATING AND DESTINATION HOSPITAL DETERMINATION

1. Request for patient destination to PACOM or to CONUS hospitals is the responsibility of the treatment facility in Vietnam within the guidelines outlined in the triservice regulation "Medical Regulating to/and Within the Continental United States" (AFR 168-11, AR 40-350, BUMEDINST 6320.1C, HSMHA CIR NO 69.2, CG COMDT INST 6320.8). Actual patient designation to PACOM and CONUS hospitals is determined by a joint medical regulating office (JMRO or ASMRO) and not by the originating medical facility or the various casualty staging units. Patients may be removed from the evacuation system at any port enroute when it is the professional opinion of the evaluating surgeon that patient health and safety will be compromised by the continued movement, whether by surface or by air. Once the decision is made to remove a particular patient from the evacuation system, the destination hospital is notified through JMRO or ASMRO by the aeromedical staging facility concerned. This is essential to avoid unnecessary delay in notification of relatives and medical personnel at the destination facility.

2. To insure minimal patient travel time enroute it is mandatory that meaningful dialogue and communication be maintained between the medical treatment facilities and the regulating agencies. Information regarding aeromedical evacuation schedules, routes and system interfaces must be fully available to and understood by both parties.

III. SPECIAL PROBLEMS

A. Tracheostomy Care. The tube should be of proper size and changed prior to patient placement in the aeromedical evacuation system. When Bird respirators are to be used the tube should be cuffed.

Humidification. Due to the low (10 percent) humidity of aircraft cabin atmosphere, the use of some humidification device is recommended to avoid the production of dry mucous plugs

and to insure proper tracheal care and toilet during flight. These devices must be specifically requested by the referring physician.

The use of tubes for tracheostomy that do not have cleaning cannulae should be avoided. It is essential that mucous plugs and encrustations be removed promptly to avoid respiratory distress and obstruction. Rubber and plastic tracheostomy tubes do not normally have cleaning inner tubes or cannulae. The periodic instillation of 3-5mm of sterile isotonic saline solution into the tracheostomy with proper aspiration enhances the cleaning of the airway.

Note: 1. Patient should not be transported with oral or nasal endotracheal tubes.

2. Only oxygen is available on aircraft. Compressed air is not available.

B. Chest Tubes: Chest tubes may be left in position during evacuation but should be equipped with functioning valves such as the Heimlich valve. Chest x-rays should be taken and interpreted just prior to patient movement. Expiratory and lordotic films to look for small or minimal pneumothoraces should be included. Preferably, the patient should not be evacuated by air within 72 hours after removal of the chest tube. Chest tubes must never be clamped when the Heimlich valve is in place.

C. Nasogastric and other Enterostomy Tubes: All patients requiring nasogastric suction at ground level should have such protection during flight with open drainage employed. Continuous naso-gastric suction is not available during flight. The combination of the basic medical problems, air swallowing due to anxiety and pain and the reduced barometric pressure at altitude could result in difficulties. Abdominal pressure under a cast, pain from distention of hollow viscera, and most importantly, vomiting with aspiration and serious pulmonary complications could result.

D. Urinary Catheter Care: Indwelling catheters in use prior to transfer should be left in place during transfer. Instructions for specific care enroute (both at staging areas and inflight) must be provided for the medical teams along the route.

E. Intravenous Catheters: These catheters should be left in position for a maximum of 48 to 72 hours only. Patients requiring intravenous catheters for fluids during flight should have them replaced within 24 hours of evacuation and the date noted. See Anesthesia Section for definitive catheter care.

F. Cerebrospinal Fluid Leak: A wound draining cerebrospinal fluid at ground level will drain slightly faster at high altitudes. These wounds are not a contraindication for transfer if such is indicated for other reasons. One notable example is cerebrospinal Rhinonhea which is a contraindication. CAUTION - See Neurosurgery Chapter paragraph 3N regarding pneumocephalus in the presence of cerebrospinal fluid leak.

G. Cranial Tongs: Special attention must be paid to the proper seating of the tongs. Traction must be maintained by a closed system, preferably with the Collins' Spring. In the absence of a spring device, traction may be maintained by heavy rubber tubing tied to the litter frame. Weights hanging free must not be left attached during any phase of ground or air movement. This prevents sudden jerking upon the tongs. See Neurosurgery Chapter for specific guidance. These patients should be transferred on a Stryker frame.

H. Stryker Frame: Portable frames are available for long distance transfers by air. Patients will be turned during transfer as ordered by the referring surgeon. Tall patients require the extra length Stryker frame. Stryker frames should be sent as a complete unit.

I. Skin Traction: See Orthopedic Section for diagrams and instructions.

J. Plaster Casts: All circular casts on patients evacuated should be bivalved utilizing the "dart" method as shown in the Orthopedic Section. This allows for the expansion of soft tissue at decreased barometric pressures as well as rapid access to a serious wound beneath the cast. Vital information clearly visible to attendants caring for the patients in the aeromedical evacuation system should be inscribed on the casts denoting date, time and type of injury, date of surgery and cast application, and a simple sketch of the bone injury.

An exception to the bivalving requirement are those patients with stabilized fracture situations in which edema or the neurovascular status is not in doubt. This should be so marked on the unbivalved cast and the patient evacuation tag (e.g., closed fracture of the navicular, stabilized malleolar fracture, etc.). Such patients should be casted at least 48 to 72 hours

prior to leaving the originating hospital.

K. Vascular Injuries: Patients who have had vascular injuries require special attention and immobilization. CASTS SHOULD BE BIVALVED AND WINDOWED TO provide easy emergency access to control hemorrhage. When tactical situations permit, primary repair or graft cases should not be transferred from the combat zone for 14 or more days post repair. Patients should not be transferred to CONUS in less than 21 days after repair. Cases transferred should have the repair date, location and type of repair inscribed on the cast or dressing. See Chapter on Vascular Injuries for further guidance.

L. Medications: Medication orders must include routine drugs such as malarial prophylaxis or eye drops as well as special items such as properly typed and cross-matched whole blood if the patient should require transfusion during movement. Certain medications, such as antibiotics, narcotics and analgesics, should have a recorded "stop order" to avoid an undesirable extension of this course of therapy. It is essential that the physician ordering evacuation complete the patient evacuation tag, DD Form 602, accurately to assure that antibiotic therapy is continued on schedule or discontinued as required. Some medications are not normally available in standard supply and when these are not to be continued during patient transfer, an adequate supply must accompany the patient in individual prescription bottles. Oral medications should be substituted for parenteral medications where feasible.

M. Ice Blankets: Do not remove a patient from the ice blanket abruptly and evacuate the patient. Equipment is not available aboard the aircraft to continue such treatment. Convulsions, high fever and respiratory distress can be expected to develop if this principle is not adhered to throughout the system.

N. Physician Attendants: Physician attendants are medical attendants from the originating or any other medical facility who are required to accompany a patient to render professional or technical care to a patient which is beyond the scope of the flight medical crew. When a patient is considered to require a physician in attendance, consideration in selecting this physician should be given to the type of care anticipated in flight. An appropriately trained physician should accompany this patient. The medical attendant assigned to a particularly seriously ill patient will accompany that individual all the time and all the way to the destination hospital.

While a physician may be present on an aeromedical evacuation aircraft in the capacity of a medical attendant to a patient (or a physician may be present as a passenger or an additional crew member) it must be clearly understood that the flight nurse in charge of the flight (variously called the MCD - Medical Crew Director or MAIC - Medical Attendant in Charge) has the ultimate authority and responsibility for the patient care area of the aircraft. The flight nurse may recommend and expect diversion of the aircraft to or from a particular destination, and he or she may refuse to accept a patient that has not been properly prepared or who may represent a threat to the welfare of other patients on the aircraft. The flight medical crew represents a formidable amount of expertise and talent in the area of patient care aboard aircraft which includes not only medical care but also knowledge of operation of special equipment and of the aircraft itself and its capabilities.

The physician who courteously identifies himself to the charge nurse as available to be of assistance as required is a most welcome addition to any aeromedical evacuation flight irrespective of the capacity in which he is traveling, and his counsel and/or assistance will most likely be sought at some time during flight. On the other hand a physician should not presume to make rounds on patients or otherwise interfere with the flight medical crew in the performance of their duties.

O. Postoperative Patients: Under normal conditions patients should not be manifested from the combat zone to CONUS unless they are 12 days or more postoperative.

P. Patients with Open Wounds: In an attempt to avoid subjecting seriously ill or injured patients to prolonged aeromedical evacuation in too close a proximity to his wounding or surgery, patients should not be evacuated by air with open wounds without staging through off-shore PACOM hospitals.

Q. Hand Patients: Hand cases should be manifested as litter patients to insure proper elevation.

R. THE DRUG ABUSER: The surgical or medical patient who is a drug abuser and who is being evacuated by air should be identified in order that this aspect of his total health care needs may

be provided for in order to preclude a drug related episode from occurring during flight. This identification should be by means of a special colored tag attached to the DD Form 602 or as ordered by appropriate regulations and should contain information regarding the type of drug being abused (e.g., heroin, marijuana, amphetamine), length of time habituated or addicted, and medication and dosage required enroute to keep patient drug reaction or withdrawal symptom free.

The patient's preflight briefing must include an opportunity for a patient to voluntarily identify his problem to those responsible for his medical care so that appropriate medications will be provided for his enroute care.

S. Regulations, Directions, Rules and Instructions Relative to Aeromedical Evacuation: There are three basic TRISERVICE regulations pertaining to aeromedical evacuation which must be followed in order to insure maximum patient care and comfort and expeditious patient movement while in the air evacuation system. EVERY PHYSICIAN must have a working knowledge and/or ready access to these directives. They are:

1. Worldwide Aeromedical Evacuation (AFR 164-1, AR 40-535, OPNAVINST 4630.9B, MCO P4630.9, CINCPACINST 4630.1A).

2. Medical Regulating To And Within The Continental United States (AFR 168-11, AR 40-530, BUMEDINST 6320.1C, HSMHA CIR NO 69.2CG, COMDT INST 6320.&, CINCPACINST 4652.1A).

3. Medical Service - Patient's Identify Tag, Patient's Baggage Tag, Patient Evacuation Manifest and Patient's Unaccompanied Baggage (AFR 160-113, SR 40-530-7, BUMEDINST 4600.2).

T. A Mnemonic Device for Physicians and all Medical Personnel Involved in the Care and Handling of a Patient who will be Placed in the Aeromedical Evacuation System: To provide a handy rule of thumb for patient preparation for aeromedical evacuation here are 4Cs and 3Ps of Aeromedical Evacuation.

The four Cs are:	Check	The three Ps are:	Patient
	Classify		Papers
	Clear		Paraphenalia
	Call-in		

When a patient is being considered or prepared for aeromedical evacuation the physician must:

Check the patient - thorough medical evaluation to resultant diagnosis.
Classify the patient - according to Chapter 5 of the Worldwide Aeromedical Evacuation directive (i.e., 1A, B or C, 2A or B, 3 or 4 which categorizes the patient as litter, ambulatory, psychiatric, etc.).
Clear the patient - through the medical officer in charge of the originating medical facility or intransit aeromedical evacuation facility or in his absence other competent authority (Chapter 4 Worldwide Aeromedical Evacuation Directive).
Call-in the patient movement requirement (by telephone or radio) to the medical regulating office and then to the aeromedical evacuation agency.

When the patient is brought to the aircraft for movement the following are required:

Patient - Self explanatory.

Papers - DD Form 602 PROPERLY AND COMPETELY FILLED OUT. Patient and Baggage Manifests properly and completely filled out, Medical Records, X-rays (Shot records, passports, and visas may also be required).
Paraphenalia - Medications, special equipment (e.g., Stryker frame, casts properly bivalved, respiratory assist devices).

U. The Patient Evacuation Tag, DD Form 602: This document (with all of its imperfections) is the document which is primarily used to give recommended enroute treatment and instructions. It must be properly, completely and legibly filled out to insure proper and optimum care to the patient while in the aeromedical evacuation system. The physician referring the patient into the aeromedical evacuation system must sign the tag. In order for the referring physician to receive feedback, follow-up information on the patient whom he has expended his best professional talents, the physician's name must be legible.

V. Fatigue: Fatigue is a significant factor in patient aeromedical evacuation. Prolonged exposure to extremes of thermal conditions (both hot and cold), rapid change from one thermal climate to another (tropical to arctic), dehydration and the degree of injury are significant factors contributing to fatigue and must be considered. The physician in the war zone must be aware of the fact that his patient may well travel from an area of ambient environmental temperature of 100°F or more to an area of 20°F or less in less than five hours. Provisions must be made for thermal comfort (proper clothing) and hydration enroute in addition to medical or surgical care.

ANESTHESIA

Anesthesiology has made many advances in the resuscitation and anesthetic care of casualties in Vietnam as compared to previous conflicts. The advent of new drugs, anesthetics and equipment have all contributed. The availability of better trained personnel in more adequate numbers has certainly been a prime factor. There are many differences between the anesthesia problems encountered in Vietnam and those encountered in day-to-day civilian practice.

Equipment, at most hospitals, at the present time is comparable to that used by anesthesiologists in CONUS. It has been possible to replace the antiquated equipment of the field type left over from World War II. Modern and safe anesthesia equipment is an absolute necessity if the more seriously wounded are to survive. Much of the equipment and many of the drugs now used in the specialty of anesthesia are new. Some are still too new to have been placed on the standard supply table. These items must be specially purchased on the open market as nonstandard items if the casualty is to be provided the outstanding anesthetic care to which he is entitled.

Due to climatic conditions and the heavy workload, equipment in general tends to deteriorate at a faster rate than in the United States, and the need for continuous preventive maintenance must be stressed.

AIRWAY MANAGEMENT

Airway management should begin on the battlefield and continue along the evacuation route until the patient reaches a treatment facility. In order to accomplish this, corpsmen should be given extensive indoctrination in airway management. Present field kits should include Geudel airways and other equipment necessary to maintain an adequate airway. The wisdom of teaching corpsmen the elements of tracheostomy and intubation is controversial. Howeverk there have been instances where the equipment was available, and a corpsman was capable of performing life-saving intubation of tracheostomy. This equipment, however, is not readily available in some areas. The anesthesiologist and the nurse anesthetist at all levels of field care should continue to teach the proper use of equipment and techniques for respiratory resuscitation. Patients on arrival should be treated for respiratory distress by the immediate insertion of either a nasotracheal or an oral tracheal tube when indicated. In casualties where adequate ventilation may be restored within 48 to 72 hours, the endotracheal tube, preferably a nasotracheal tube which is better tolerated, should be used rather than a tracheostomy as the first approach in airway resuscitation. In patients who require tracheostomy because of severe wounds, the initial use of a nasal or oral endotracheal tube will convert the procedure from an emergency to an elective one performed under controlled conditions. In the management of respiratory problems, tracheostomy is recommended in the following instances.

1. In severely traumatized patients, where either the danger of aspiration or the need for assisted ventilation or anesthesia exists, a cuffed tracheostomy tube adaptable to both resuscitative and anesthesia apparatus should be used initially.

2. In the comatose patient where the aspiration of vomitus is a potential problem.

3. Where adequate tracheobronchial toilet must be accomplished to prevent complications of the already compromised pulmonary system.

4. In patients who will require prolonged (longer than 72 hours) respiratory assistance in the postoperative period and during evacuation out of country.

The following are recommended in the care of a tracheostomy tube or an endotracheal tube:

1. The use of a prestretched plastic tracheostomy cuff (e.g., Portex) will decrease the incidence of late tracheal stenosis. This is done by immersing the cuff in 90°C water for 10 minutes, gently inflating the cuff to 20cc then cooling while inflated.

2. After insertion of the tracheostomy tube in the patient the cuff is inflated with just enough air to allow a minimal leak. Hourly deflation is unnecessary with this technique of prestretching and "minimal leak."

3. Prior to deflating the tracheostomy cuff the oropharynx should be suctioned, then with the lungs inflated the cuff is dropped so the patient can "cough" and clear the trachea. This avoids aspiration of pooled secretions.

4. (See tracheostomy care under Aeromedical Evacuation section.)

5. Suctioning of tracheostomy tube or endotracheal tube:

a. Aseptic technique should be employed.

b. Many wall suction units will withdraw excessive amount of air (up to 30 liters per minute); therefore, the suction catheter should be quickly passed in and out of the trachea with suction applied only as the suction catheter is withdrawn.

c. The patient should be allowed to take at least four breaths spontaneously or artificially ventilated at least four times between passage of suction catheter into the trachea.

d. It is advised that prior to suctioning, the patient be given 100 percent oxygen to breathe for at least two minutes in order to reduce the risk of hypoxemia.

Bag, mask and non-rebreathing valve combination such as the AMBU bag have made mechanical resuscitators obsolete. The bag, mask and non-rebreathing valve combination is considered to be a better unit for emergency resuscitation because it is simple to use, inexpensive, maintenance is negligible, it is readily adaptable to most all types of artificial airways, and it does not require an oxygen source but may be adapted to oxygen easily. If oxygen is supplemented through the intake attachment, the oxygen flow rate should be watched to prevent malfunction of the valve which will result in excessive pressure delivered to the lung. Such pressure may rapidly rupture the alveoli. Non-medical and paramedical personnel can easily be trained in its proficient use.

A significant number of casualties have serious pulmonary problems in the postoperative period. Some of these patients die if adequate intensive respiratory care is not instituted. Assistor controller type respirators are readily available in Vietnam and are used extensively. However, they sometimes cannot adequately ventilate the often encountered patient who has decreased pulmonary compliance and increased airway resistance. In these patients, the volume limited respirator rather than the pressure limited respirator is more effective. The adjustment of ventilators, mainly flow rates, volume and the percentage of oxygen, should be determined by a physician. The use of continuous positive pressure ventilation (CPPB) will frequently improve PO2 in the patient with severe postoperative respiratory distress or "wet lung" syndrome.

PREMEDICATION

The need for routine premedication of patients does not exist. Atropine, when needed, should be given intravenously just prior to the induction of anesthesia.

TECHNIQUES

There are many considerations to make in the choice of anesthetic technique. The patient's overall condition should be the primary consideration. Will he tolerate the intended anesthetic techniques? Operative site is another prime consideration. The experience of the anesthetist is the other most important factor in the choice of anesthetic technique. Those physicians with the most experience will tend to block where at all possible. The majority of patients undergoing surgery in Vietnam are anesthetized under general anesthesia. This is usually accomplished by a thiopental-type induction and maintenance with halothane, nitrous oxide and oxygen. This technique with or without relaxants has been the method of choice in most cases requiring general anesthesia. The advantages of halothane in a combat zone include its rapidity of induction, ease of administration, non-explosiveness and applicability. In addition it should be stated that the rapid emergence from anesthesia and the lack of nausea and emesis postoperatively reduce the requirements placed on personnel of the surgical intensive care unit. Halothane is a potent vasodilator and no doubt increases peripheral perfusion. In many patients it is difficult to obtain or maintain an adequate blood pressure, especially on induction. Halothane is not introduced in a markedly hypotensive patient. In such a hypotensive patient a nitrous oxide, oxygen technique may be used being supplemented with or without a narcotic and/or a muscle relaxant as indicated. The recent studies in the halothane controversy indicate that the problem is one of hypersensitivity with repeated exposures to the drug rather than a true hepato-toxicity. Many hospitals in Vietnam are using repeated halothane anesthetic exposures on the same patient.

Methoxyflurane has been found useful in the following situations:

1. Dressing changes and short procedures where a strong analgesic effect is needed.

2. The high risk patient who is brought to the operating room for other than the initial surgery or who is hypoxic on 100 percent oxygen.

3. Where nitrous oxide might be hazardous.

4. Methoxyflurane produces excellent muscle relaxation and in some circumstances may be preferred rather than the muscle relaxant drugs.

The greatest disadvantage of methoxyflurane is its long period of emergence which in a war zone may also be coupled with the lack of adequate recovery room facilities.

Neurolept analgesia. Example Innovar: This has been found to be a good analgesic for burns. It is also useful in supplementing a weak regional anesthetic or a regional anesthetic such as a retrobulbar block in ophthalmology or a laryngeal nerve block in ENT. It, however, is a mixture and the phenothiazine component should not be repeated.

Muscle relaxants: It is strongly recommended that in those cases requiring muscle relaxants an adequate amount be given to accomplish the desired relaxation. Adequate relaxation will save many valuable minutes of operating time.

Ketamine. This dissociative anesthetic has been used in the patient with an airway problem, burn dressing, fracture manipulation, etc., with good results. Flashbacks have occurred, however, up to six weeks later.

Curare is proving to be the relaxant of choice. Its advantage being its ability to be reversed pharmacologically. A disadvantage of curare is the hypotension which one may see with a rapid injection.

Flaxedil, a nondepolarizing relaxant with a shorter half life than curare, may also be employed. But because of its anti-vagal effect it may mask a valuable monitor, the pulse rate.

Succinylcholine drip is useful for short procedures. Disadvantages of succinylcholine drip are:

1. There is the danger of overdosage leading to a phase II block or a prolonged block in the rare patient with an atypical pseudocholinesterase.

2. There is a need for an extra IV for the succinylcholine drip and this is not always available.

3. When administered at an excessive rate arrhythmia may be troublesome.

4. It has been noted in patients with burns, massive tissue injury, hemiplegia and paraplegia there is a vulnerable period between two and 10 weeks postinjury when the administration of succinylcholine may cause arrhythmias leading to cardiac arrest resulting from hyperkalemia. During this period succinylcholine should be avoided. If succinylcholine must be used during this vulnerable period, six to nine milligrams of curare intravenously five minutes prior to the succinylcholine may decrease the rise in serum potassium. Also during this vulnerable period, recent studies have shown that gallamine actually decreases the serum potassium level and may thus be a preferred agent.

Intubation: Acute gastric dilatation in the wounded is a very common occurrence. It is seen even in patients with minor wounds. It is probable that combination of fear, pain and air transport contribute to gastric dilatation. Forceful intermittent positive pressure breathing during resuscitation will compound this problem by pumping air into the stomach.

Trauma patients in general should be assumed to have a full stomach and, therefore, a rapid induction and intubation is utilized in most all casualty patients. The following is recommended as an acceptable technique for rapid intubation. To avoid the possibility of vomiting with aspiration, one may pass a nasogastric tube to evacuate air and liquid contents of the stomach. In order that the gastroesophageal junction not be held open, the nasogastric tube is then removed. At this point, give 3 mg to 6 mg of curare intravenously which will greatly reduce the increase in intragastric pressure from the fasciculations of succinylcholine. In the traumatized patient preoxygenation with 100 percent oxygen for at least several minutes prior to rapid induction is done. As rapid induction commences with the rapid injection of thiopental followed by succinylcholine, the cricoid cartilage is depressed firmly against the body of the vertebrae by an assistant. This Sellick maneuver will compress the esophagus and will help prevent passive regurgitation. This pressure must be maintained by the assistant until the cuff on the endotracheal tube is inflated within the trachea. In the severely wounded patient it is not infrequent that neither thiopental nor succinylcholine are required for tracheal intubation.

Spinal anesthesia: Spinal anesthesia is used in most hospitals. Although best used for isolated wounds of the leg, buttocks or perineum, a combination of spinal anesthesia plus a brachial plexus block or other regional anesthesia can be used for wounds of three extremities. It is to be emphasized that when spinal anesthesia is to be utilized a careful evaluation of the status of the cardiovascular system should be made. Many of these battle casualties, especially during the dry summer months, may be very dehydrated.

Brachial plexus block is the other frequently used regional technique in the management of the field casualty. The axillary approach is the recommended approach. A supraclavicular block is an excellent block for the shoulder and arm. The success of such a block depends upon the skill and the experience of the physician. The supraclavicular intrascalene techniques of Winnie and Collins have shown themselves to be safe and effective. A recommended maximum dosage schedule for Xylocaine is 7mg/kg.

Sciatic, femoral and lateral femoral cutaneous nerve blocks have been found to be very useful blocks for single leg injuries. The lateral femoral cutaneous block is often ideal for the donor site for a split thickness graft.

Intravenous local anesthetic blocks, although easily administered, are best used for patients who have minimal tissue or vessel disruption. The disadvantage of this technique is that the tourniquet may need to be released to evaluate the small vessel damage.

PROBLEMS

TEMPERATURE REGULATION

With the availability of air conditioning hypothermia is becoming more of a problem. Body temperatures below 92°F can lead to cardiac arrest. Attempts to maintain body temperature should be made. Blood warming coils can be used for both blood and IV fluids. The use of intra-abdominal warm irrigations have been shown to be of value and are strongly recommended where indicated.

Temperature should be checked on admission. Hyperthermia is extremely common in casualties in Vietnam. Elevated temperatures are often due to the combination of heat and dehydration, malaria and/or infections secondary to delay in transportation from the field. Febrile patients should be cooled toward normal temperatures as rapidly as possible and preferably before an anesthetic is administered. Equipment to induce hypothermia should be available. Conventional methods such as high flow techniques and use of vasodilators such as halothane will aid in this problem. The use of air conditioned operating rooms has done much to help alleviate this problem which was troublesome during the first few years of this war. The wounded patient's temperature should be monitored continuously. The anesthetist should be aware of any significant change in temperature and should be ready to aggressively cool the patient should a hyperthermia develop. One must not overlook the possibility of a fulminating hyperpyrexic situation in the wounded patient.

RESPIRATORY DEPRESSION WITH THE USE OF ANTIBIOTICS

Attention should be directed to the respiratory depression or apnea noted after the use of Kanamycin or Neomycin solutions for lavage and/or instillation into body cavities. Streptomycin, dihydrostreptomycin and polymyxin B may also cause the same type of apnea. This is dangerous if the surgical team is unaware of its occurrence. This type of respiratory paralysis is due to a calcium-magnesium imbalance. The treatment of an antibiotic induced apnea rests in continued ventilatory support. One might also reverse this magnesium type paralysis with intravenous calcium, watching of course for any changes in the electrocardiogram. Neostigmine may only serve to aggravate the situation.

FLUID AND BLOOD REPLACEMENT

The casualty who is usually dehydrated from field duty requires a minimum of two liters of lactated Ringers solution plus a compensatory blood volume replacement. In the severely traumatized casualty where multiple wounds exist and blood loss has been extreme, several intravenous routes should be established. Large bore Rochester-type needles are recommended (Jelco or Angiocath). When cutdowns are necessary, it is recommended that the superficial femoral or upper extremity veins be utilized. It has been found that cutdowns in the ankles do provide an avenue for adequate fluid therapy, but it is difficult to administer blood through this route. The controls on this route are distant from the anesthesiologist and make it a difficult route to

administer. In patients with major wounds of the abdomen and pelvis, only the veins of the upper extremities and neck should be utilized. This is to avoid the possibility of extravasation of transfused blood into the traumatized area. The intravenous route through the subclavian vessels has been used with increasing frequency. Complications tend to decrease as medical officers become more familiar with the technique of tapping this vessel. The complications recorded and documented are hemothorax, pneumothorax, postoperative parathesias in the extremity, tension pneumothorax, massive hydrothorax caused by inadvertent infusion of replacement fluid into the pleural space, and air emboli. The route should be used only after due care is taken to assure proper placement in the subclavian vessel. The catheter should be treated with meticulous daily skin defatting, antibiotic (Neosporin) ointment and sterile occlusive redressings.

Blood types to be used. When the patient arrives in the triage area and the first IV is started a blood clot should be obtained for immediate typing and cross-matching. The most desirable blood for transfusion is as fresh as possible, group and type specific and completely cross-matched. Availability of this desirable situation requires about 40 minutes. Group-specific blood with an immediate spin saline cross-match requires 15 minutes. Low titre O+ blood may be obtained immediately. During periods of increased need for blood, care should be taken to request no more than immediately needed so that the cross-matching capacity of the laboratory is conserved and utilization of available units is maximized. A cross-matched unit on the shelf is not available to another patient. If the patient needs blood immediately he should receive O+ blood. If it is determined that the patient is not type O+ and he had not received more than three units of type O+ blood, he can be changed to type-specific blood without difficulty. If he has already received four or more units of type O+ blood, he should continue to receive type O+ blood. If it is determined after typing that the patient is type A+ he may receive type A+ blood without cross-matching.

When the patient has received type O+ blood rather than type-specific blood and is returned to surgery within a few days he should be typed and cross-matched for type specific blood. If he has not received large amounts of type O+ blood he will usually have re-established his own blood type within four days. If he can be cross-matched he should continue to receive type O+ blood. It has recently been shown that a transfusion of over 15 units of ACD blood may result in a platelet deficit which will often result in clinical bleeding and can be controlled with freshly drawn blood. Two units of fresh whole blood may be given every 10 units prophylactically if available.

Depending on its availability, it is especially desirable that the last two to three units infused be freshly drawn blood. This blood should be drawn from individuals who have just arrived in country whenever possible. One should not hesitate to draw blood from people who have been in country for some time when faced with this life-threatening bleeding problem. Fresh frozen plasma contains all factors except platelets and should be used when platelet activity is adequate.

In a patient with uncontrollable oozing following massive transfusion, a coagulation workup should be carried out prior to or simultaneously with treatment. This should consist of an examination of a peripheral blood smear for platelets, a prothrombin time (PT), a partial thromboplastin time (PTT), a Page Test and a Clotting Time. The Pate Test (0.9cc blood and 0.1cc topical thrombin) clots instantly if fibrinogen is adequate.

Generally a simple dilution of coagulation factors is characterized by a prolonged PT and PTT with normal fibrinogen and platelets and can be treated with two to three units of FFP. If platelets are depressed fresh blood is indicated.

Hemorrhage due to Disseminated Introvascular Coagulation is characterized by prolonged PT, PTT, depressed platelets and poor clot on Page Test. Treatment here is first Heparinization to stop the DIC then Fibrinogen. If evidence of fibrinolysis is noted the patient can be treated with E.A.C.A. (Amicar).

In many hospitals, the use of one ampule of sodium bicarbonate for every three to five units of blood is routine. This practice can be used where intraoperative blood gas analysis is not available. If blood gas analysis is available and utilized, bicarbonate administration will be found unwarranted.

Massive blood transfusions require that blood be warmed during administration to avoid adverse effects on the cardiovascular system. Blood warming coils are available on standard supply and should be used.

Each unit of blood administered should have a new blood filter so as to decrease the number

of microparticles in the blood that enter the patient's blood stream. This may help decrease the number of microemboli in the lungs that are believed to be one of the causative factors in the "wet lung syndrome."

Overtransfusion does occur, although infrequently, usually in patients with bilateral, high, lower extremity amputations. Utilization of packed cells should be considered in these cases rather than whole blood. When suspected, prompt diagnosis should be established by physical signs and symptoms and/or central venous pressure determinations. Under continuous central venous pressure monitoring, therapy consists of phlebotomy, intermittent positive pressure breathing and digitalization if indicated. Undertransfusion is the usual problem, and the condition is aggravated in the immediate postoperative period by oozing from raw surfaces. In the severely wounded patient, central venous pressure, urinary output, vital signs and clinical evaluation of the patient are the minimal criteria to be used as guidelines for the rational use of blood. Except when mass evacuation is required, these patients should be retained at the initial treatment facility for a minimum of 24 to 48 hours to stabilize their cardiovascular systems.

CROSS INFECTION FROM ANESTHESIA AND INHALATION THERAPY EQUIPMENT

The following routines are considered standard to prevent cross infection by the cleaning of anesthesia and inhalation therapy rebreathing equipment:

1. Rubber rebreathing tubes, face mask, rebreathing bags and head straps.

   a. Thoroughly wash with a detergent and scrub with a brush.

   b. Wash with PhisoHex for five minutes or soak with Wescadine for ten minutes. Insure complete submersion by covering with a weighted object.

   c. Rinse thoroughly; use potable or sterile water for rinsing.

   d. Dry.

2. Endotracheal tubes, oral airways, nasal airways, esophageal stethoscopes, plastic tubing and connectors for inhalation therapy machines.

   a. Thoroughly wash with a detergent and scrub with a brush.

   b. Rinse thoroughly.

   c. Rough dry.

   d. Immerse completely for a minimum of ten minutes in full strength Cidex solution. Insure complete submersion by covering with a weighted object.

   e. Rinse thoroughly; use potable or sterile water for rinsing.

EVALUATION OF EVACUEES: PACOM HOSPITALS

The above comments concerning the care of the severely traumatized patients in Vietnam apply to all patients who may arrive in PACOM hospitals for treatment from the field. However, the majority of patients being received at the present time from Vietnam have had at least one anesthetic prior to transfer. Except under periods of unusually heavy casualty flow, most of these patients will have been stabilized and adequate pulmonary function established prior to evacuation. However, when these patients are transferred out of country in the immediate postoperative period, fatigue develops and some dehydration and additional contraction of the blood volume is known to occur. Upon arrival in the PACOM hospitals, surgery and anesthesia should be delayed for at least 24 hours to permit rest and evaluation prior to induction of anesthesia for another surgical procedure. During this time the surgeon-anesthesiologist team can obtain the appropriate laboratory and x-ray studies and provide adequate hydration and blood replacement.

DEBRIDEMENT

Debridement is the surgical technique of excising devitalized tissue and removing all foreign material detrimental to wound healing. Experience in several wars has demonstrated that proper debridement is the key to successful surgical treatment of soft tissue wounds and provides the best means of reducing morbidity and mortality. In spite of widespread acceptance of this premise, in each conflict the surgical technique must be relearned. Through his own experience and with guidance from more experienced combat surgeons, each surgeon must develop an appropriate technique of debridement based upon the ballistic effects of high velocity wounds and the pathology of the combat wounds, which are entirely different from most civilian low velocity wounds. Whenever possible, results of debridement should be inspected by the surgeon and a constant determination to improve skills should the goal.

For massive wounds when many anatomical structures are involved, debridement may be a very challenging operation in which the surgeon must choose between leaving tissue of questionable viability or causing morbidity by removing viable and functional tissue.

BALLISTICS

The extent of tissue damage is related to the type of missile, velocity, rotation and tumbling and the type of tissue involved. The elasticity of the skin allows stretching as the missile passes through; therefore, damage does not usually extend far beyond the traumatized edges. Excessive skin debridement is unnecessary and will make subsequent closure more difficult. Damage to fascia is related more to loss of substance from a direct effect rather than destruction from lateral energy. The innocuous appearance of the fascia may disguise extensive cavitation beneath. The subfascial plane is a ready avenue for extension of infection after improper debridement. Skeletal muscle is the tissue least able to withstand the shock wave and cavitation caused by dissemination of lateral energy from a high velocity missile. Devitalized muscle can be recognized by dark color, soft consistency, non-contractility and decreased bleeding of the cut surface. Arterial injuries may be encountered as complete transections, open tears, small holes occluded with thrombus, contusions with intimal tears, contusions with aneurysm formation, and, rarely local spasm. Hematomas adjacent to vessels should be explored to rule out vascular injury. Tendon and nerve fibers withstand lateral energy better than skeletal muscle. Since inspection will readily demonstrate the extent of devitalized tissue, conservative debridement is recommended.

TECHNIQUE

Debridement with an electrocautery is not condoned. A stepwise surgical plan, detailed knowledge of anatomy, careful technique, thoroughness and good judgment are necessary for consistent success. The operation should progress in an orderly fashion with each tissue plane being properly treated as it is encountered.

SKIN. For extremities longitudinal incisions are preferred because they permit any necessary extension for adequate exposure and are more easily closed at a later date. When joint creases are traversed, a curved incision to prevent contractures is indicated. Following the initial skin incision the skin wound is debrided. The ragged, devitalized skin edges should be excised with a scalpel, taking only a few millimeters of normal-appearing skin. Excessive skin debridement is unnecessary and circular defects are to be avoided.

FASCIA. The fascia should be opened widely. As noted previously, it may appear almost normal and yet hide extensive underlying muscle destruction. Shredded loose fascia should be excised. After opening the fascia, frequently a bulging hematoma is uncovered. This should be carefully evacuated by suction, irrigation and sponging. Copious irrigation at this time may be effective in flushing out clots, debris and foreign material and exposing vascular or other injuries.

MUSCLE. All devitalized muscle should be excised by sharp dissection. The criteria for viability are color, consistency, contractility and type of bleeding. Good hemostasis to prevent excessive blood loss and hematoma formation postoperatively is imperative. Mine explosions are prone to hurl massive quantities of soil into the wounds, and such matter may travel a considerable distance through fascial planes. Copious irrigation and surgical removal of this material is time consuming but is essential to prevent infection. A reasonable effort should be made to remove all foreign bodies in and around the missile track.

TENDON. Tendon does not usually require extensive debridement beyond the grossly destroyed fibers. Loose, frayed edges and ends should be trimmed. Repair of severed tendons should not be

performed during the initial treatment of combat wounds. Tendons should be covered with soft tissue when feasible. Developing rotation flaps for this purpose should not be done. Drying of exposed tendons is avoided by covering them with a strip of wiped vaseline or other impregnated gauze before the dry dressing is applied.

NERVES. Nerves do not require extensive debridement. Loose strands and all grossly destroyed tissue should be removed. To prevent additional displacement of transected nerves, the epineurium amy be tacked to adjacent soft tissue utilizing non-absorbable fine suture material other than silk. Nerves also must be covered by soft tissue. The digital and facial nerves may be repaired primarily if feasible. Nerve grafts should not be performed during initial debridement.

VESSELS. All wounds in the vicinity of major blood vessels must be explored thoroughly for vascular injury. A distal pulse does not rule out vascular damage. Missed arterial injuries will almost invariably lead to some type of significant complication.

BONE. Clean, loose fragments of bone should be retained whether detached or not in an effort to prevent possible shortening of an extremity. The fragment should be debrided and thoroughly cleansed if necessary and then returned to its normal anatomic location. Retained pelvic bone fragments associated with bladder or colon wounds frequently become sequestered, perpetuating infection; therefore, these should be removed at the initial surgery. When arterial injuries are near unstable fractures, spicules of bone near the repair should be smoothed to preclude subsequent trauma to the repair. Formal arthrotomy should be performed in all wounds involving joints. (See Orthopedic Section.)

Surgeons are cautioned that in treating patients injured by blast from ground level; rocks, fragments or other foreign material may be hurled upward through tissue planes a considerable distance from the point of entry in the skin. Careful attention and often wide skin incision as well as wide opening of fascial planes may be necessary to remove all foreign material which, if left behind, will lead to infection.

Upon completion of debridement the wound shoudl be a healthy appearing cavity with clean tissue edges and adequate exposure of the depth of the wound. Hemostasis is imperative as large quantities of blood can be lost by continued oozing from multiple wounds. Following final inspection of the defect, the wound should be dressed with sterile fine mesh gauze without drains. For deep wounds, fluffs of gauze should be laid over the fine mesh gauze but the wound should not be packed. Packing produces a "cork," plugging the wound and preventing adequate drainage.

Clean dressings need not be removed until the time of delayed primary closure or redebridement unless signs of infection are present. Complicated or extensive wounds may require special dressing techniques.

Patients having extensive soft tissue wounds of the extremities should have the extremity immobilized in a position of function. Casts are preferable to splints as the latter tend to break down, and inadequate immobilization has resulted in further tissue loss.

DEBRIDEMENT OF SPECIAL REGIONS

FACE. Due to the abundant blood supply and complex anatomic structure of the face, less extensive debridement should be performed. Thorough cleansing is mandatory. These wounds should be closed primarily if possible. An attempt should be made to obtain skin closure without flaps, reserving their use for a more ideal time. Split thickness skin grafts may be used as coverage in large avulsed wounds. (See section on Maxillofacial Injuries.)

NECK. Explore all wounds to rule out vascular, tracheal or pharyngo-esophageal injuries. The neck should be closed primarily after debridement. It is advisable to place a drain to the depth of the wound despite a negative exploration. (See section on Maxillofacial Injuries.)

CHEST WALL. When the intercostal muscles and pleura are involved, a check should be made for intercostal artery bleeding. Defects in the chest wall may require rotation of a flap of muscle or skin and subcutaneous fat to obtain air-tight closure. Exposed costal cartilage should be covered to reduce thepossibility of chondritis.

ABDOMEN. Individual wounds of the abdominal wall require debridement. If a laparotomy is performed, a separate incision through normal tissues should be used whenever possible.

Turning patients to the prone position for debridement of posterior wounds following prolonged thoracic or abdominal procedures should be avoided. Such debridement should be done prior to the major procedure if the patient's condition permits or it may be delayed until 24-36 hours postoperatively when the patient's condition has stabilized.

HAND. Hand wounds should be left open following debridement. Again, excessive, needless tissue loss is to be avoided. (See Orthopedic Section.)

EXTERNAL GENITALIA. Because of abundant blood supply of the external genitalia, less extensive debridement is required and primary closure with dependent drainage should be performed. Conservatism in testicular debridement is indicated and coverage of exposed testicular tissue should be achieved.

FOOT. Foot wounds have been a problem due to inadequate debridement of the plantar tissues. The bulk of soft tissues in the foot is located on the plantar surface and adequate debridement through a hole on the dorsal surface is impossible. If a deep wound is present, a plantar incision is required. The majority of surgeons have a natural tendency to shy away from plantar incisions fearing a painful scar subsequently. There should be no hesitancy in making a plantar incision to debride the foot. Properly placed incisions between the metatarsal heads avoiding the weight-bearing areas are recommended. Foot wounds are not to be closed. (See Orthopedic Section)

COMMON ERRORS IN DEBRIDEMENT

A. Overlooking or missing a wound. Areas in which this is likely are: (1) perineum; (2) rectum; (3) back; (4) scalp; (5) axillae; (6) oral cavity and nasopharynx; (7) beneath previously placed dressing.

B. Pin hole debridements or inadequate exposure.

C. Minimizing the damage hidden under a small surface fragment wound.

D. Coring wounds and inserting drains.

E. Failure to debride through-and-through wounds of an extremity from both surfaces.

F. Removing excessive skin.

G. Gauze dressings packed to become a water and air-tight seal.

H. Improper splinting.

I. Incisions placed in improper directions.

Redebridement is frequently necessary. This does not necessarily mean that the original debridement was improperly done. Surgeons should not hesitate to return a patient to the operating room for further debridement or reinspection of the wound, particularly in cases of extensive or multiple injuries.

DELAYED PRIMARY CLOSURE

Delayed primary closure can be effected most satisfactorily approximately four to seven days after adequate initial debridement. It is realized that some wounds will require further debridement and the closure must be delayed for four to seven days more. Depending on available anesthesia capabilities, regional or local nerve block will frequently provide adequate analgesia at the time of delayed primary closure. For large tissue defects, general anesthesia is advised. If the wound appears clean on examination no skin edge excision is recommended and the wound surface should be disturbed as little as possible. Excision of the granulating wound bed at the time of closure is not indicated. Undermining of the skin edges and the creation of new planes of dissection should be avoided if possible. In some situations coverage of the wound with split-thickness skin graft is desirable in the four to seven day period. This is better than attempting to close widely separated wound edges under excessive tension. The wound should be closed with non-absorbable, non-reactive suture which should not be buried. Undue tension at the time of closure is to be avoided. Micropore tape closures have proved successful in many instances and can be accomplished without anesthesia. In-country delayed primary closure is to be avoided unless the surgeon is able to follow the wound long enough prior to evacuation to insure the absence of suppuration.

VASCULAR INJURIES

A high index of suspicion must be maintained if the diagnosis of vascular injury is not to be missed. Unless a definite distal pulse is felt, an arterial injury must be assumed until proven otherwise. The presence of a pulse does not necessarily rule out arterial injury since distal pulses are usually present beyond false aneurysms and arteriovenous fistulae. Some arterial wounds are not diagnosed until wound debridement. Thorough and complete debridement of all devitalized tissue is of the utmost importance at the initial operation. This does not preclude the need for redebridement whenever and wherever dead tissue is identified. Contusions of the artery without interruption of flow may be associated with an intimal tear with resultant thrombosis.

BEFORE ANY TYPE OF ARTERIAL REPAIR IS ATTEMPTED AND PARTICULARLY BEFORE A COMPLICATED REPAIR IS CONTEMPLATED, THE SURGEON MUST ASSURE HIMSELF THAT THE EXTREMITY IS SALVAGEABLE. The repaired artery must be surrounded by clean viable tissue for nourishment and to prevent drying, thrombosis, infection, disruption, and hemorrhage. Ligated vessels must also be covered by viable tissue.

The radical debridement of 1 cm. beyond grossly viable injury is not necessary and has contributed to a high rate of vein grafting. It is,therefore, recommended that the injured blood vessel be debrided conservatively, serially if necessary, until the judgment of the surgeon the artery is grossly normal and that a direct anastomosis be achieved whenever possible. An anastomosis must not be performed with the vessel under undue tension. Such will only result in spasm and thrombosis or disruption and hemorrhage. Neither excessive dissection, nor sacrifice of important arterial branches and collateral vessels should be practiced in order to obtain a direct anastomosis. If a defect in an artery is too great for anastomosis, then a vein graft should be utilized. Vein grafts should be only of sufficient length to maintain normal arterial tension. Postoperative heparinization is not necessary,however, flushing with heparin solution of the distal segment is indicated. If back flow is not adequate, passage of a Fogarty catheter is recommended.

Lateral repair in peripheral arteries should be avoided. The repair of popliteal trifurcation or brachial bifurcation arteries should be attempted. Ligation of major arteries at initial surgery should be avoided.

The saphenous vein is the most useful vein for graft purposes. For lower extremity injuries involving both the artery and vein and requiring a vein graft, the saphenous vein from the opposite extremity should be utilized whenever possible to minimize the further compromise of the injured leg's venous drainage.

In wounds with associated major venous injury, vein repair should be performed where possible. Every effort should be made to repair popliteal veins. Venous repair is accomplished by lateral suture, end to end anastomosis or venous replacement grafting using the contralateral saphenous vein.

If, after adequate arterial repair, a distal pulse does not return within three to four hours and there is concern for limb viability, there should be no hesitancy in re-exploring the arterial repair. The use of arteriography can be helpful. There should be no urgency, however, if adequate capillary circulation is present. Before multiple reoperations are performed, the surgeon should equate the danger to the patient's life with the danger of loss of limb. Most limbs and some lives have been lost following three or four reoperations to salvage a vascular repair.

Late loss of pulse with continued limb viability is not in itself an indication for urgent reoperation. Ill-timed re-explorations within the first four to six weeks after repair often result in a second failure. Many patients with absent pulses develop adequate collaterals and are asymptomatic. Further definitive operations should be undertaken only in CONUS.

Hemorrhage following an arterial repair may be due to incomplete arterial debridement, faulty repair, or infection. Hemorrhage in the presence of gross infection should be controlled by ligation. If it appears that the limb will be lost with ligation, then extra-anatomic venous bypass may be considered. In the presence of a leaking arterial repair where gross infection is not present, repeat repair may be successful with careful wound toilet and appropriate antibiotic coverage.

All wounded extremities should be examined by auscultation and palpation for unsuspected false aneurysms and arteriovenous fistula. The elective repair of stabilized, intact,uninfected traumatic arteriovenous fistual and aneurysms should not be attempted in a combat zone.

Arterial injuries associated with an unstable fracture can pose a significant problem. Arterial repair must be done in a matter to insure adequate length of the artery when the fracture is reduced. Ideally, reduction of the fracture should be done with the arterial repair site in view to assure that there is no undue tension. Soft tissue should be placed between the fracture and the artery and a circular cast applied. These casts are to be bivalved and windowed to allow ready access to the arterial repair. Skeletal traction,if indicated, should be applied cautiously. Internal fixation is condemned.

Fasciotomies are most often indicated after severe ischemia, prolonged lag time from arterial injury to repair, popliteal artery injuries, major venous disruptions, and significant soft tissue contusion. Fasciotomy should be done without hesitation when one or more of the aforementioned conditions are present. Fasciotomies should generally be done at the time of initial repair rather than waiting for compartmental pain or swelling by which time the beneficial effects are minimal. Skin incisions should be adequate to permit full length incision of the fascia and inspection of the muscle. Skin incisions over the anterior tibial compartment should be placed well away from the lateral border of the tibia to allow opening of the anterior and peroneal compartments and to prevent adherence of the skin margin to the tibia. Both the superficial and deep groups of muscles of the posterior compartment may be decompressed by a posteromedial fasciotomy. Skin incisions are not closed primarily. Delayed primary closure is ordinarily not feasible making skin grafts necessary.

Even with fasciotomy necrosis of muscles in the legs following popliteal artery repairs can occur. The anterior compartment muscles and the deep muscles of the posterior compartment are most vulnerable. When it is determined that irreversible changes have taken place, the involved muscles must be excised early.

Carotid artery injury rarely causes special problems. Repair should be accomplished without haste; internal shunt is not usually necessary. The repair of a carotid artery in the presence of hemiplegia continues to be controversial.

Because of the danger of hemorrhage during air evacuation, patients with arterial repairs should not be evacuated from the combat zone for 14 or more days. If there is any suspicion of infection or leakage, the patient should be retained in country until the question is resolved. If evacuation becomes necessary, the patient should be accompanied by a medical officer. Where positioning an extremity is required to prevent undue tension, the windowed cast or splint should be left in place for evacuation.

Every attempt should be made at all levels to report names and identifying data of patients with vascular injuries to the Vietnam Vascular Registry at Walter Reed General Hospital. This is doubly important for any patients returned to duty outside of CONUS. This registry and study is proving extremely valuable to the military medical services.

Address:

Vietnam Vascular Registry
ATTN: MEDEC/GSG
Chief, Peripheral Vascular Surgery
Walter Reed Army Medical Center
Washington, D.C. 20012

NEUROSURGERY

INTRODUCTION

We recommend that the order of priorities in multiple injury patients continue as delineated in all of the basic surgical texts. First attention must be dedicated to airway maintenance and control of bleeding. Other associated injuries should be thoroughly searched for if shock is present and appropriate treatment carried out. Only then do the separate problems relating to the head or spine injury warrant attention. Life-threatening neurosurgical wounds consist of rapidly expanding intracranial masses and injuries to the major dural sinuses or intracranial arteries. General treatment of closed head injuries in combat situations should be the same as treatment in non-combat situations.

CRANIOCEREBRAL TRAUMA

1. Penetrating wounds - Management and recommendations:

A. X-rays: Preop films in at least two planes. Postop x-rays in at least two planes as soon as possible after surgery. Stereo x-rays and image intensification fluoroscopy, when available, are frequently of great value in ruling in or out penetration of the cranial vault by metallic fragments. All patients with head or scalp wounds, no matter how trivial, should have skull x-rays. Roentgenograms should be carefully retained and upon ultimate patient transfer all preoperative and postoperative films must accompany the patient.

B. A complete head prep should precede a thorough debridement of skin, skull, dura and brain.

C. A meticulous search for any imbedded foreign material must be conducted, removing all such foreign material that can be removed without compromising vital centers of the brain or causing significant neurological crippling. Clusters of retained bone fragments are presumptive evidence of inadequate debridement. Foreign material removed during debridement should be cultured. Decisions as to the removal of bone fragments or metallic fragments when they are in crucial areas require the exercise of the finest judgment of the well-trained neurological surgeon. Certainly all fragments to which access can be safely gained should be removed. Because of the previous dogmatic insistence upon the removal of all retained bone fragments, however small and regardless of where located, cases have been reported where reoperations have been performed to remove suspected retained fragments, and after extensive searching the bone fragments have not been found. In some of these cases because of the increased trauma to the brain, primarily in the search for deep fragments, significant worsening of the patient's neurological condition has resulted. In view of the factors cited, the arbitrary removal of small bone fragments from vital centers or neurologically important areas when (1) the wound has been meticulously debrided without gaining access to the fragment, and when (2) the attainment of a route of access to the fragment would result in probable increase in risk to the life of the patient or probable significant neurological crippling, does not appear warranted. The decision must rest with the surgeon in each individual case as to whether a given fragment should be removed, based on all available information, including:

(1) Size of fragment.

(2) Location of the fragment

(3) Possible routes of access to the fragment.

(4) Knowledge of possible complications resulting from retained intracerebral fragments.

D. Make every effort to achieve either primary closure of dura or dural closure with pericranium, temporalis fascia, galea or fascia lata.

E. Always achieve primary scalp closure, utilizing scalp flaps by rotational methods if necessary and covering the defect thus created with split thickness skin grafts at the donor sites.

F. Management of retained fragments seen on postoperative films should be subject to the same considerations as outlined in paragraph C above. Under certain conditions, such as increased patient load or decreased combat area security, the best course of action in stable patients with retained fragments, might be to air evacuate patients from the combat zone to the PACOM hospital

system for their secondary procedures.

G. Recent cases in Vietnam have shown intracranial fragments of low radiographic density appearing to be bone fragments, but which on removal have proven to be metallic alloys of low atomic weight.

H. The use of brain mass reducing agents is often indicated and should be governed by the individual clinical situation. No significant complications have resulted from their use. Marked fluid restriction and dehydrating agents have been most helpful, but strict attention should be paid to adequate electrolyte replacement and to the electrolyte balance in the post-operative phase. Hyperventilation as an adjunct to reducing intracranial hypertension and vascular congestion, especially during the operative period, is strongly recommended.

I. If, following debridement, the missile tract fills in or persistent cerebral edema is a problem, incomplete debridement or undetected hematoma should be suspected.

J. Anticonvulsant medications should be administered in all cases of portical damage and should be continued throughout the evacuation chain.

K. Prophylactic antibiotics in all cases are recommended; see the section on antibiotics. Antibiotic coverage should be instituted prior to definitive surgery and continued through the surgical procedure into the postoperative period.

L. All CSF fistulas should be closed prior to further evacuation, if practicable.

M. Exenteration of the paranasal sinuses, whenever they are involved, should be carried out. In general, packing or rubber tube drainage of major sinus wounds should be considered.

2. Tangential Wounds - Management and Recommendations:

Tangential wounds may appear on inspection to be minor injuries. It should be remembered that these wounds may show severe dysfunction of the brain under intact coverings and should be treated accordingly. Subdural, epidural and intracerebral hematomas are occasionally associated with high velocity tangential wounds. Angiography, if available, may be of value to rule out such lesions.

3. General recommendations:

A. Preoperative and postoperative neurological evaluation is mandatory and adequate records must be available to afford optimal management of the patient at subsequent hospital facilities.

B. Acute cranioplasty is never indicated.

C. When available, blood gas studies have frequently proven of significant value in craniocerebral trauma where the level of consciousness is depressed.

D. Intermittent positive pressure breathing is strongly recommended for the prevention of pulmonary complications in the patient with a depressed sensorium.

E. Simultaneous cranial and abdominal and/or extremity debridement is frequently indicated to promote more rapid and expeditious use of limited operative facilities and anesthesia personnel, particularly in the face of mass casualties. Minimal anesthesia and operative time will also be to the patient's advantage.

F. Drains should be avoided except in unusual circumstances. Bank dura and freeze dry dura should not be utilized. Radiopaque cottonoids and/or cotton patties with strings should be used in the debridement of craniocerebral trauma. The use of foreign substances such as gelfoam and bone wax should be kept to a minimum.

G. Unless exigencies of the combat area dictate to the contrary, incisions for craniotomies/craniectomies should be made to provide the optimal cosmetic result. To this end, incisions should be kept well behind the hairline whenever practicable. Plan incisions to assure adequate blood supply to scalp flaps. In general, an "S" shaped scalp incision has proven to be more advantageous than a standard scalp flap. Continuous running single layer closures are contraindicated due to difficulty of maintaining adequate galeal tension and

simultaneous accurate scalp closure. Wound healing with their use has been unsatisfactory.

H. Craniectomy of the involved bone should be carried out in all cases of bone penetration or fragmentation. Some surgeons have expressed the opinion that in view of the gross contamination of penetrating craniocerebral war wounds, craniotomy should not be attempted, but only craniectomy used to gain intracranial access. Statistics showing an increased infection rate with craniotomy as compared to craniectomy are not presently available. If craniotomy is utilized, the probable increased resistance to infection provided by the vascular supply to the bone plate afforded by the myo-vascular pedicle of osteoplastic craniotomy as contrasted to the avascular free bone flap craniotomy should be considered. Frontal injuries with frontal sinus and orbit involvement frequently require craniotomy for appropriate debridement and invariabley require meticulous attention to water-tight dural closure.

I. Use of teflon or other synthetic subsititues in venous sinus repairs has been associated with significant infection and should not be used. Saphenous vein, fascia or autogenous dura are recommended for venous sinus repair.

J. Gross brain infection should be treated with aggressive debridement and aggressive antibiotic coverage. Rarely, when faced with extensive cerebritis and cerebral fungus, the open method should be considered when more conservative measures have been to no avail. Gram negative infections, particularly Pseudomonas, Klebsiella and Proteus, are far more prevalent in craniocerebral injuries than was heretofore suspected. Appropriate and intensive antibiotic coverage should be seriously considered whenever contamination with these agents is suspected.

K. Postoperative spinal taps may be of value. Arteriography is occasionally helpful in the postoperative period, but seldom preoperatively in the case of penetrating injuries.

L. Whenever it appears likely that a fragment may have transversed the cranial vault, striking the inner wall of the vault at a point other than the point of entry, and therefore rebounding within the vault, at least an exploratory burr hole should be made at the suspected point of rebound. Frequently hematoma or brain maceration of significant magnitude will be found, dictating further definitive surgery and debridement.

M. Air evacuation should not be undertaken in the presence of entrapped intracranial air, unless aircraft with the capability of maintaining sea level internal pressure is used. When a cerebrospinal fluid leak is present, air evacuation should be discouraged. The increase in CSF egress seen with decreasing pressure in these cases is undoubtedly coupled with an ingress of fluid and air when the cabin pressure again increases . This ingress will carry with it significant elements of contamination, and should be avoided if conditions permit.

N. Patients with craniocerebral trauma with dilated fixed pupils, and who are reflexic, unresponsive and requiring respiratory support following correction of shock and hypoxia should not be considered neurosurgical emergencies and should be treated expectantly. Patients who have improvement in their neurological status following resuscitation, or in whom reflexes or responses are present may be helped by neurosurgical intervention and should be transported to an appropriate treatment facility as soon as possible.

O. It should be borne in mind that patients with small penetrating crnial wounds are not self decompressing, as are the more massive cranial wounds, and may clinically demonstrate progressive cerebral decompensation. Rapid increases in intracranial pressure due to expanding lesions may require urgent decompression. Administration of hyperosmotic agents prior to arrival at a neurosurgical facility may be life-saving, but must always be preceded by placement of a urinary catheter. It is cautioned that these agents should be reserved for those patients exhibiting signs of deterioration.

SPINAL TRAUMA

1. Treatment of compound penetrating injuries (usually by missile) of the spinal axis and its contents.

A. Early, adequate debridement of the wound following well proven, general surgical principles is necessary with special attention to careful, complete laminectomy and removal of the devitalized tissue and bone fragments.

B. Complete decompression of the spinal cord or cauda equina, removing compressing bone or metallic fragments must be performed. In view of the known difficulty of roentgenographically

demonstrating bone injury in the spine, patients with neurological deficit and a projected missile path transversing the spine should have laminectomy. Metal fragments within the spinal canal should,in general, be removed even though asymptomatic.

C. Maximum effort to obtain dural closure utilizing lumbar fascia or fascia lata as necessary should be made; other dural substitutes should be avoided.

D. Isolation of the spinal wound from any other wounds is mandatory. Experience suggests that leaving the laminectomy wound open followed by delayed primary closure may occasionally be the method of choice. (See paragraph E).

E. The statistics on the mortality and the morbidity of certain combined wounds are alarming and require joint study and recommendations. Specificially, those compound wounds involving the spinal cord and the abdominal area, usually with involvement of the kidney or colon, subsequently developing infections, have resulted in a higher mortality rate. Probably more adequate original debridement, better drainage of the area, and earlier attention to the febrile patient would result in improved mortality and morbidity statistics. Delayed evidence of spinal osteomyelitis has been noted. Of interest is the relatively low incidence of meningitis and the ability of the subarachnoid space to seal itself early in missile wounds. Those patients with meningitis, almost invariably have continued contamination by an abscess in communication with spinal canal. In an effort to preclude this continued contamination, continuous perfusion/drainage of antibiotic solution via ingoing and outgoing catheters into the area should be considered. In these patients most often the neurosurgical aspect of the case is not the one of immediate concern. Nevertheless the neurosurgeon should be involved in the early care of the patient and delayed laminectomy is to be considered in the same light as delayed debridement. It is well known that early decompression of neural tissue gives the best hope for functional recovery.

2. Injuries with neurological deficit caused by missiles involving the pelvis,abdomen, chest or neck without x-ray evidence of spine involvement.

A. Generally neurosurgical investigation is recommended when the patient's condition permits. Surgical intervention is undertaken at the judgment of the neurosurgeon depending upon his analysis of the pathology involved in the neurological deficit. Cases with complete block should be decompressed. There is a lack of unanimity concerning the value of surgery in other cases where block is not present.

B. High velocity missile wounds through the pelvis have been reported to have resulted in sacral fracture and disruption of the dura due apparently to the pressure/blast wave; at least without direct contact of the missile with the sacrum. A high index of suspicion should be maintained for such injuries, and if found, the usual measures to effect dural closures should be undertaken. Further, the measures listed in 1.E. above, as well as diverting colostomy, should be considered to eliminate continued meningeal and cerebral spinal fluid contamination.

3. Closed injuries from blunt trauma.

A. Patients with known or suspected cervical fractures should be transferred to a neruosurgical facility with sandbags or similar immobilization. The improper application of cervical traction is potentially hazardous. Lateral cervical spine x-rays which extend to the C7-T1 level must be obtained to adequately rule out cervical fractures.

B. The general principle of early neurosurgical evaluation and treatment is again emphasized. However, one cannot be dogmatic about surgical intervention in all cases - the individual surgeon's training and judgment being most important in the specific situation.

C. The use of steroids is generally recommended. Hyperosmotic agents may be considered.

D. Progressive neurological deficits demand rapid surgical attention.

E. In cases where (a) closed reduction of dislocation of the cervical area cannot be obtained by the usual skeletal traction methods, or (b) significant deformity of the spinal canal exists, either as demonstrated by plain x-ray or myelography, or (c) spinal canal fluid block is found at lumbar puncture or myelography, decompression laminectomy is indicated.

4. Other significant factors in management of spinal cord injury are:

A. Suprapubic cystostomy is to be avoided, unless it is absolutely mandatory.

B. Indwelling Foley catheter should be used during initial care and treatment. Complete agreement on the frequency of catheter change and irrigation and type of irrigation agents has not been attained. Appropriate antibiotics, acidifying agents and external cleanliness should be employed to minimize the urinary tract infections.

C. Intermittent catheterization either QID or TID is not desirable in war theater conditions.

D. The catheter should be taped to the abdomen to avoid peno-scrotal fistulae.

E. Fusion-stabilization of the spine may be necessary in these injuries, and where indicated should be performed in CONUS after good wound healing, without infection, is assured.

F. Aggressive paraplegic or quadriplegic care with attention to pulmonary, intestinal and urinary tract function and prevention of infections should be maintained.

G. The use of the Stryker, Circo-lectric or Foster frame is recommended and is mandatory for good skin care.

H. The possible masking of intra-abdominal pathology in the high paraplegic, or intrathoracic pathology in the quadriplegic, must be constantly considered. It must be remembered that rigidity, guarding and pain, and sometimes even fever are absent in these patients in the presence of intra-abdominal abscess, peritonitis, and fistulae. Appropriate diagnostic procedures initiated early when such pathology is suspected.

I. Paraplegics and similarly disabled patients should be evacuated to CONUS at the earliest time possible for expeditious transfer to the special rehabilitative facilities of the Veterans Administration.

5. Non-Battle injury, back pain management.

A. Patients with low backpain syndromes have been received in the PACOM hospitals and CONUS after myelography, but without corrective surgery. Frequently the myelogram was lost in transit or had to be repeated in CONUS. Certainly it is most desirable that myelography be performed by or under the supervision of the surgeon who is going to do the definitive disc surgery. Therefore, since elective disc surgery should not be done in the combat area, elective myelography in the combat area is not indicated.

B. Patients with loss of bowel and bladder control or significant or progressive loss of motor function are in an emergency category and must have early myelography and definitive care.

THORACIC SURGERY

GENERAL CONSIDERATIONS

Of those admitted to hospitals thoracic wounds represent about seven percent of wounds according to body location. The inherent lethality of such wounds is emphasized by the fact that chest wounds are the second leading cause of death on the battlefield after head injuries. However, few patients who survive to reach a definitive treatment facility in Vietnam die as a result of thoracic wounds and management of these patients has produced overall consistently excellent results. The major problems in managing such patients are:

1. Management of the severely wounded patient with multiple injuries in whom chest injury is only one of several major problems.

2. Progressive pulmonary insufficiency (wet lung or shock lung).

3. Confirming the need for formal thoracotomy.

Conservative management without thoracotomy is the rule and less than 10 percent of patients will require formal thoracotomy. Vigorous, conservative, aggressive management is necessary whether or not the patient requires operation later. Improvements which have evolved from the Vietnam experience are:

1. Earlier and more frequent use of large caliber chest tubes. There are few indications for thoracentesis as a therapeutic measure. Suction should be applied to all chest tubes when the patient arrives at a hospital location.

2. More frequent use of positive pressure ventilatory assistance to include assistance during initial evacuation and use of volume limited respirators in the hospital.

3. Use of blood gas determinations as an indication of the severity of injury and the effectiveness of therapy.

4. Conservatism and careful monitoring of fluid and blood replacement to avoid overloading. Experience has shown that the patient with direct high velocity penetration or a tangential wound with kinetic energy contusion of pulmonary parenchyma is far more susceptible to overloading than heretofore acknowledged despite youth and previously normal cardiorespiratory dynamics.

The overall goals in chest injury management are to:

1. Obtain a clear tracheobronchial tree.

2. Remove all possible blood and air from the pleural cavity.

3. Obtain and maintain maximum pulmonary expansion.

4. Replace lost blood and restore normal blood volume.

INITIAL CARE IN FORWARD MEDICAL FACILITIES (IN-COUNTRY FACILITIES FORWARD OF THE HOSPITAL)

Early application of emergency care procedures is essential in thoracic injuries. These include:

1. Insuring a clear upper airway and maximum possible ventilatory exchange.

2. Use of occlusive dressings on all chest wounds.

3. Splinting of the chest wall with bulky dressings.

4. Positioning of the patient with injured side down or transportation semi-erect if feasible.

5. Venting of the pleural cavity with a chest tube when indicated.

6. Early encouragement of deep breathing and coughing.

7. Initiation of fluid therapy.

8. Use of nasal oxygen if available and indicated.

The airway and ventilation should be assured by any means at hand, including mouth to mouth resuscitation, use of the AMBU or even intubation or tracheostomy at forward areas. Maintenance of therapy may be required during initial evacuation.

Placement of chest tubes at forward locations and use of the Heimlich valve during evacuation have been most beneficial and are relatively free of complications. A single plastic tube of large bore (36 to 40 F) should be placed in the low anterolateral chest on the side of injury avoiding potential thoracotomy sites. Although it is recognized that misplaced and ill-applied tubes can be hazardous, the risks are acceptable when weighed against benefits. Medical officers at all levels should receive specific training in this relatively simple but life-saving procedure. The technique of chest tube placement is considered sufficiently important to warrant discussion. The key to success in placement of a chest tube is adequate local anesthesia. Wide infiltration of the entire thickness of the chest wall and pleura insures that the chest tube can be placed easily and expeditiously without additional harm to the patient. A short skin incision is made over the selected site and the tissues are dissected down to the pleura which is then penetrated. Use of a sharply pointed trocar or an instrument to force the chest tube through the chest wall can be dangerous and is not recommended. The chest tube should be secured with sutures and tape. A reasonable effort should be made to direct the tube posterior to the lung since posterior dependent drainage of blood is desirable. Use of this dissection technique may allow a small amount of air ingress during tube placement. This is not critical as long as the tube functions well later. Experience with the Heimlich valve has shown that it is more efficient in removing the air than blood. The valve must be attached and placed properly. Instances were reported in which the valve was inserted backwards, the tube was clamped proximal to the valve, valves were broken and the plastic bag was not vented.

INITIAL HOSPITAL MANAGEMENT

Even if forward resuscitation has been adequate, attention to ventilation and the upper airway will probably be the first problem requiring attention on hospital admission. An adequate airway must be assured to include intubation or tracheotomy if necessary and immediate mechanical ventilatory support should be used without hesitation if required for proper ventilation. Fluid and blood replacement, relief of pain to enhance coughing and patient positioning are all essential early measures. Adequate intravenous routes should be established, and include use of arm cutdown and percutaneous subclavian or external jugular cannulation. These provide a secure route for fluid administration as well as central venous pressure monitoring. Daily aseptic care for such catheters is mandatory. Chest x-rays and blood gas determinations should be obtained at the earliest opportunity.

The various steps in evaluation and resuscitation should proceed concurrently and should be completed expeditiously. Another important consideration is that the response to these measures is often a valuable clue as to the need for subsequent operative intervention.

If a chest tube has not been previously inserted, then a single large bore tube should be placed in the lateral chest wall in the anterior axillary line for immediate venting. X-ray examination prior to tube placement is not required if hemopneumothorax is suspected from physical examination. It should be remembered that occlusion of the open chest wound as an emergency measure may, on occasion, produce a closed tension-type penumothorax.

Considerable forethought should be given to x-ray examination so that all desired films are obtained at one time, thus avoiding the trauma of additional patient movement. Supine AP and overtable lateral views are usually adequate to assess intrapleural air or blood accumulations and to locate fragments. Upright films are especially valuable for more precise evaluation of lung expansion, pleural space compromise and chest tube placement. However, such views should be deferred in unstable patients since placing the patient upright may constitute a "tilt test" causing cardiovascular collapse in hypovolemic patients. Supine AP and lateral abdominal views should be obtained on all thoracic injury patients.

Constant adequate suction of 20-30 cm water should be applied to the underwater seal in all cases. The goals are rapid evacuation of air and blood from the pleural cavity and early lung expansion. Respiratory dynamics and tube patency can be checked by temporarily disconnecting suction to the underwater seal. Plastic tubes with radiopaque markers should be used since these clot off less readily.Additional drainage holes should interrupt the marker so as to show

their location. Plastic tubes are prone to air leakage at connecting sites and needle holes. The system should be checked for spurious air leaks and if plastic chest tubes are cleared by insertion of air through a needle, the needle hole should be sealed securely with heat or tape. Generally speaking, irrigation into the pleural cavity to unblock chest tubes is not advised nor is use of enzyme solutions. A non-functioning chest tube is best replaced using a new site rather than reusing the contaminated previous entry site.

Although the lung may appear fully expanded on x-ray, patients with intrapleural injury may develop pneumothorax under anesthesia. Consideration should be given to placement of a chest tube prior to anesthesia or constant alert should be given to this occurrence during operation. Apical lordotic and expiration films may demonstrate a small pneumothorax not seen on routine views. After operation, additional films should be obtained. Portable upright views can usually be obtained at this time.

Failure of lung expansion can be due either to pleural space compromise or tracheobronchial obstruction. Vigorous tracheobronchial toilet should be continued to avoid blockage by secretions. Relief of pain to permit voluntary coughing may be obtained by judicious use of narcotics and intercostal nerve block. Nasotracheal suction or suctioning of the artificial airway must be utilized repeatedly and aggressively with due consideration for upper airway trauma, inappropriately prolonged suctioning, and aspiration due to gagging. IPPB and even physiotherapy are appropriately employed early after injury or operation in most patients.

OVERALL TYPES OF MANAGEMENT

Generally patient management falls into three categories.

1. Conservative management of intrapleural damage with debridement and delayed primary closure of the superficial part of the chest wall in accordance with priorities established for any wound. This includes stabilization of the chest wall by any means necessary to include ventilatory assistance and tracheostomy. About 87 percent of patients will be so managed.

2. Use of the wound or an extension of the wound for a limited thoracotomy and intrapleural exploration during wound debridement under endotracheal anesthesia. In general, extension of the wound for access should be done on specific indication and when the wound is properly located, not severely cotaminated and problems in closure will not result. About five percent of patients will be managed in this manner.

3. About eight percent of patients will require one of the various types of formal thoracotomy which is performed on specific indication.

INDICATIONS FOR THORACOTOMY

In order of frequency the indications for thoracotomy are: (1) bleeding; (2) the chest wall wound itself; (3) mediastinal injury; (4) air leakage; and (5) use of a small right thoracotomy to close the diaphargm when this is not possible at laparotomy.

Continued or massive intrathoracic bleeding has been the major indication for thoracotomy. Usually such bleeding comes from systemic vessels of the chest wall. Frequent observation of drainage bottles and chest tube function and x-rays are essential. The amount of bleeding cannot be specified; surgical judgment must be employed to determine if continuing significant blood loss occurs during and after resuscitation.

Large wounds and defects of the chest wall present an obvious requirement for at least a limited thoracotomy.

Mediastinal injury can be suspected from the appearance of the chest x-ray and determination of the probable missile course. As experience has been gained in Vietnam a more aggressive approach to exploration for large vessel or esophageal injury has become warranted, since the consequences of neglected injury to important mediastinal structures may be exsanguination or liefe-threatening sepsis.

Massive air leakage requiring thoracotomy is not a common indication and the condition should be managed conservatively to determine the size and location of the laek. With suction discontinued temporarily, the patient who can develop negative intrapleural pressure on inspiration probably does not have a major bronchial injury and in general will not require operative management. The diagnosis of bronchial rupture may be confirmed by bronchoscopy or

bronchography. Usually time is available for thoracic surgical consultation while conservative treatment is underway.

Most diaphragmatic penetrations can be closed at time of laparotomy. Rarely injury of the central right diaphragm may be inaccessible from below and in such cases closure thorugh a small right thoracotomy incision is indicated. Any diaphragmatic rent not accessible or known to have been overlooked at abdominal exploration should be closed to forestall a biliary-pleural fistula or herniation of abdominal contents into the pleural cavity. The timing and choice of operative approach are best determined individually.

Thoracotomy and resection have been advised for extensive pulmonary contusion manifested by lobar consolidation and hypoxemia not responding to oxygen therapy. The rationale is to remove a massively injured lobe which may become the nidus for progressive pulmonary insufficiency. CAUTION: The results of such management have been equivocal and most pulmonary contusions respond to conservative treatment. Thoracotomy should be considered only after documentation of the threat to life from continued failure of the PO2 to respond to ventilatory assistance and high O2 flow - or massive hemoptysis - and after thoracic surgical consultation has been obtained.

SURGICAL MANAGEMENT

Small wounds are debrided under local anesthesia and a seal obtained by approximating the muscles with a few deep sutures. The skin may be closed loosely if there is no contamination or devitalization although delayed primary closure of the skin and subcutaneous tissue is probably best. Larger wounds of the chest wall require general anesthesia and endotracheal intubation for surgical management. The skin and subcutaneous tissue should be left open for delayed primary closure. If the pleural cavity is open, inspection and any necessary corrective measures should be employed. These are generally limited to careful inspection of the chest wall to insure that hemorrhage is controlled, clearing the pleural cavity of blood and clots and removal of partially detached lung. Usually, the original chest tube is replaced by anterior and posterior tubes for optimum drainage using new sites and not through wounds of entrance or exit.

Chest wall defects should be closed with adjacent normal tissue. The use of prosthetic materials is not condoned. Muscle flaps should be devised to close the defect without tension. If this is not possible, closure of the skin over the defect with reinforcement by a bulky dressing may be necessary. Rib fragments should be removed and injured rib ends should be smoothed to prevent subsequent lung damage. Chest wall instability should be anticipated and managed by tracheostomy and controlled ventilation as in any flail chest.

Separate formal thoracotomy is usually performed for one of the previously mentioned indications. The choice of incision is individualized although a standard posterolateral approach is probably best unless median sternotomy seems advised for mediastinal vascular injury. The incision should be placed to avoid compromise of tissue between the incision and a nearby wound. Pulmonary resection should be avoided if only contusion or through and through missile holes are present. Suturing of lung parenchyma for control of surface air leakage is unnecessary, although control of parenchymal bleeding is indicated as in any pulmonary operation. Lobectomy may be indicated when there is massive destruction or hilar damage to bronchus or vessels. Lobectomy is generally preferred to attempts at major bronchial repair especially if tailoring or a complicated, tenuous repair is required.

INJURIES TO THE HEART AND GREAT VESSELS

With rapid helicopter evacuation from the battlefield a significant number of patients with major cardiac and great vessel injuries survive to reach a medical facility. An aggressive operative approach is employed for bleeding or tamponade and exploratory operation is warranted when it appears probable that the missile has transversed vital mediastinal structures. Cardiopulmonary bypass is not required for support of such operations.

Cardiac tamponade should be suspected in all patients who do not respond to the usual resuscitative measures for patients with thoracic injury. It should be especially suspected in those patients who demonstrate a missile fragment on x-rays in the location of the heart or great vessels. Persistent rapid pulse and respiration were considered suspicious of tamponade. Distention of the neck veins, elevation of central venous pressure, decreased systolic pressure, narrowed pulse pressure and quiet heart sounds were considered significant findings. A large cardiac silhouette is not necessary for the diagnosis. Paradoxical pulse and blood pressure are relatively late findings.

Parazyphoid needle aspiration should be done for diagnosis and to aid in stabilizing the patient's condition. If blood is obtained on aspiration immediate thoracotomy should follow. Repeated therapeutic aspiration is not advised. Median sternotomy is usually employed for mediastinal bleeding although associated injury may dictate use of a posterolateral incision.

In the absence of bleeding or tamponade exploration merely to remove metallic fragments should not be done. Even late removal of fragments in CONUS is not indicated unless hemorrhage, infection, effusion or other complications develop.

WOUNDS OF THE ESOPHAGUS

Wounds of the thoracic esophagus are rarely seen because of the protected position of the organ and high mortality associated wounds of the heart and great vessels. However, the unrecognized esophgeal rent is potentially lethal. Preoperatively, radiopaque studies are indicated when a missile tract can be identified as passing close to the esophagus. Use of barium is not contraindicated. At the time of thoracotomy, the esophagus should be exposed in these types of wounds. Suture closure and drainage by intrapleural chest tube is the treatment of choice leaving the mediastinal pleura widely open. If closure is not technically feasible, careful dependent catheter drainage is mandatory.

THORACO-ABDOMINAL INJURY

The method of choice is to manage the thoracic injury conservatively and perform abdominal exploration as the chest problem comes under control. This can be done in about 75 percent of instances. If both thoracic and abdominal explorations are necessary the site of initial exploration is determined by the clinical condition of the patient. Separate incisions are recommended rather than a thoraco-abdominal incision. However, a thoraco-abdominal incision should be employed without hesitation when required for control of massive liver or caval bleeding. In most instances total management of abdominal injuries through the thoracotomy incision alone is not possible and should not be attempted. In all penetrations of both chest and abdomen, the diaphragm must be repaired with non-absorbable suture.

PROGRESSIVE PULMONARY INSUFFICIENCY (PPI) ASSOCIATED WITH THORACIC AND NON-THORACIC TRAUMA

During the early Vietnam experience post traumatic progressive pulmonary insufficiency (PPI) (also called wet lung or shock lung) emerged as a significant factor in the death of severely wounded patients. Most frequently it followed direct pulmonary trauma, but was also seen in non-thoracic trauma such as burns, massive extremity damage and abdominal injury. Although a full understanding of the etiology and pathophysiology of "wet lung" has yet to be gained, detailed clinical analyses have led to employment of preventive and therapeutic measures which have markedly reduced the incidence of death due to this cause. In brief, fluid overloading coupled with various insults to alveolar air exchange or pulmonary capillary perfusion--or both--provides the most frequent clinical setting for development of progressive hypoxia, and later hypercarbia, leading to death. Avoidance of overload during resuscitation and surgery, extensive use of blood gas monitoring and aggressive pulmonary supportive care are key factors in the recent marked decline of PPI in combat casualties.

The various factors identified frequently in the initiation of the process are previous hypoxia due to shock or hypoventilation, accumulation of pulmonary secretions, blood and gastric aspirate, embolization to the pulmonary microcirculation, parenchymal contusion and vigorous or massive blood and fluid administration. Within the lung a ventilation-perfusion block develops from fluid accumulation in the alveoli and interstitial tissues, increased capillary permeability, blockage of pulmonary capillaries, atelectasis with surfactant loss and pulmonary venous constriction. Release of serotonin, accumulation of particulate matter from banked blood, bacterial endotoxins, and fatty acid liberation are other damaging factors that may influence or perpetuate the process at the tissue level. The chemical syndrome is not unlike that produced by massive pulmonary fat embolism.

CLINICAL MANIFESTATIONS

PPI is characterized clinically by progressive hypoxia despite normal or hyperventilation. Manifestations are tachypnea, tachycardia, decreased pulmonary compliance and increased veno-arterial shunting. In the early phases, clinical signs of hypoxia are not apparent and initial chest x-rays and CVP measurements may be normal. The earliest indications of PPI is arterial blood gas analysis which shows hypoxia (PO2 less than 60 mm Hg) and hypocarbia (respiratory alkalosis due to shallow hyperventilation).

Later chest x-rays may reveal diffuse, fluffy infiltrates, atelectasis and consolidation which characteristically progress to involve previously clear lung areas. The x-ray picture commonly lags behind clinical and physiologic deterioration and the CVP does not reflect the severe interstitial and alveolar edema that is present. If inadequately treated, there is progressive hypoxia which becomes unresponsive to increased inspiratory oxygen concentration, decreasing pulmonary compliance, and finally hypercarbia, respiratory and metabolic acidosis and death.

TREATMENT

Irrespective of etiology the basic pulmonary lesions of PPI--diffuse interstitial and alveolar edema, atelectasis, and blockage of pulmonary microcirculation--will resolve if the patient can be kept alive during the critical phase. Equally important full preventive treatment should be instituted in "high risk" patients and those manifesting PO2 depression despite conventional oxygen therapy.

The key aspects of treatment are:

1. Controlled ventilation with tracheostomy and a volume-limited respirator.

2. Restriction of fluid intake.

3. Vigorous diuresis.

4. Heparin administration in less than anticoagulant doses.

Other measures employed are :

1. Antibiotic therapy. Patients with PPI are especially susceptible to pulmonary infection. Therapy should be guided by repeated culture and sensitivity of tracheobronchial organisms. During respirator care with a tracheotomy, the respiratory flora universally changes to an overgrowth of potentially invasive organisms.

2. Meticulous aseptic atraumatic pulmonary toilet is essential for aforementioned reasons.

3. Sedation is necessary to allay anxiety and permit proper synchronization of breathing efforts with the respirator. A times curare is necessary for controlled ventilation and to reduce the energy expenditure of ineffectual voluntary respiratory effort.

4. Decadron has been given empirically because of theoretical benefits in reducing platelet aggregation and promoting resolution of capillary and interstitial damage.

5. Thorazine has also been administered on an empiric basis for its possible benefit in correcting pulmonary hypertension or venous constriction.

Controlled Ventilation. Tracheostomy is usually required but a trial with endotracheal intubation may be justified. Full humidification should be employed to prevent "pure" dehydration. Expiratory tidal volume, inspiratory oxygen concentration and respiratory rate must be carefully monitored. The Wright ventilometer or a similar device is useful in this respect. Blood gas analyses and calculation of pH and base excess are essential frequent monitors of the efficacy of ventilatory control and therapy. Oxygen flow should be adjusted so that only the minimum concentration necessary to keep PO2 between 60 and 100 mm Hg is required. Under prolonged therapy with high concentrations and pressure there is evidence that oxygen toxicity may induce pulmonary damage. It should also be recognized that over-vigorous respiratory therapy in the absence of airway obstruction but with a perfusion deficit and arteriovenous shunting may produce hypocarbia (respiratory alkalosis) along with hypoxia from shunting. In such instances dangerous cardiac arrhythmias may be promoted. PCO2 should be kept around 35-40 mm Hg by adjusting rate, volume and dead space.

There is recent evidence to indicate the continuous positive pressure breathing (CPPB) may be of more benefit than IPPB by increasing arterial PO2 with lower oxygen concentrations and by keeping potentially unused alveoli working. Most respirators either have or can be adapted for this capability.

Mechanical ventilation may be required for several days, and weaning from the respirator depends on an improving clinical condition and adequate arterial blood oxygenation.

Prolonged intubation and mechanical ventilatory support with an inflated tracheostomy tube cuff can cause tracheomalacia and tracheal stenosis. The techniques of "pre-stretching" tracheostomy tube cuffs and "minimal leak" cuff inflation should be used to prevent this serious late complication.

Fluid Restriction and Diuresis. Generally fluids should be restricted to about 1500 ml/day during acute phases. Rapid administration of as little as 500 ml of saline has precipitated pulmonary edema. Furosemide is administered in doses (40-100 mg) larger than normally recommended. Diuresis of five to six L/day may occur without alteration of vital functions.

Heparin Administration. Heparin should be administered in divided doses of one to three mg/kg per 24 hours. Ordinarily for the average adult 25 mg IV every four hours provides the desired effect without causing clinical anticoagulation. The presumed benefits of Heparin at this dose level are to counteract hypercoagulability as may occur in low-flow states, dehydration, and sludging; to reduce platelet aggregation and thrombus formation; and to provide a secondary antiserotonin effect. Heparin also is of empirical value in treating hyperlipemia and fat embolism. Alcohol and dextran have been used for similar effects but create a problem in total fluid administration.

LATE COMPLICATIONS

The most frequent late complications are recurrent pneumothorax, bronchopleural fistula, clotted hemothorax, empyema and unresolved parenchymal hematoma.

Pneumothorax has recurred at all echeolons of medical treatment. The presence of a fully expanded lung is no guarantee that this complication will not occur.

Current experience from PACOM hospitals indicates that decortication is required in only 1% of chest injury patients received at this level. Vigorous physiotherapy and measures to improve lung expansion usually results in remarkable improvement obviating the requirement for decortication.

Empyema is seen in very few patients. Standard treatment methods consist of closed tube drainage, then conversion to open drainage. Observation from Army hospitals in Japan reveals this method of treatment has been successful in the majority of cases.

Pulmonary parenchymal hematoma will usually resolve without complications. Occasionally these will cause sepsis or hemorrhage. Evaluation by a thoracic surgical specialist should be obtained.

EVACUATION PROCEDURES

Patients should not be evacuated for at least 72 hours after chest tube removal and a chest x-ray interpretation to include lordotic or expiration films should be obtained just prior to evacuation irrespective of the timing of chest tube removal.

Patients with active chest tube drainage should have evacuation deferred. If evacuation is unavoidable then the Heimlich valve should be attached to the chest tube with full recognition that the valve is no substitute for underwater seal suction drainage. As a precautionary measure the valve may be attached and chest evaluation obtained 24 hours later--and before evacuation. The valve should be checked for correct alignment and the bag should be vented.

INTRA-ABDOMINAL INJURIES

General

The occurrence of intra-abdominal abscesses continues to be a major problem following injury to abdominal viscera. Establishment of adequate drainage is an absolute necessity if the incidence of this significant complication is to be reduced. Effective drainage can be obtained if the following recommendations are observed:

1. Placement of drain site in a dependent position-posterolateral abdominal wall. This principle has been continuously violated. Anteriorly placed drainage is not adequate. The abdominal wall must be prepped and draped widely ("table to table") in anticipation of proper drain placement.

2. Adequate size stab wounds for drain site (two fingers).

3. Use of multiple Penrose drains.

4. Frequent movement of drains.

The study group felt that sump drainage should also be utilized, particularly in the subphrenic spaces and in the pelvis. When drainage diminishes, frequently in 48 to 72 hours, the sump drain can be removed. This will avoid the danger of injury to adjacent viscera by the semi-rigid tube. Concurrently inserted Penrose drains should be left in place.

A midline incision is recommended for abdominal exploration. Interrupted wire sutures are recommended for the fascial layer. Additionally, and especially if peritoneal soiling is found, wire retention sutures may be used. There should be properly spaced and tied without tension over protective tubing to avoid compromise of rectus muscle blood supply and subsequent disasterous abscess formation and loss of abdominal wall tissue. Skin closure will depend upon the amount of peritoneal contamination.

STOMACH

Debridement of wound edges, hemostasis and two layer closure of the wound have been most effective in the management of the majority of gastric wounds. On occasion, resection with gastroduodenostomy or gastrojejunostomy may be necessary. Depending upon the extent of resection performed, vagotomy may or may not be added. Thorough exploration of the posterior gastric wall must be performed.

LIVER INJURIES

The principles involved in handling liver trauma include adequate drainage, suture for hemostasis, resection of devitalized tissue and drainage of the biliary tree. All liver wounds should be afforded adequate dependent drainage. It is mandatory that the drainage incision be large and placed as far posteriorly as possible. The use of sump drains is recommended in hepatic trauma of any significant magnitude. Suture of liver substance is primarily to secure hemostasis and stop biliary leakage. Care should be taken not to suture the liver capsule over an intrahepatic cavity which could provide a setting for future hepatic abscess or hemobilia. All devitalized liver tissue must be debrided and in more severe cases, this may approach the point of total hepatic lobectomy.

There are three main degrees of liver wounds reported. The first is a wound created by low velocity fragments penetrating the substance of the liver. Such wounds usually present with minimal to moderate bleeding and limit anatomic disruption of the liver. They are treated by debridement, hemostasis and external drainage.

The second is one which is due to missile fragments causing shattering of the liver parenchyma and hemorrhage of a moderate to severe degree. Resective debridement, hemostasis and effective external drainage are required. Biliary tract decompression may or may not be indicated. It is in this type of wound that surgical judgment is needed to decide whether hepatic lobectomy will be necessary to control the hemorrhage.

The third type of liver wound is that caused by high velocity missiles with extensive shattering or maceration of liver substance. This is always associated with severe hemorrhage which should be suspected as coming from the hepatic veins or intrahepatic cava. There should be no hesitation to extend the incision into the chest for control of hemorrhage and prevention of air emboli. It is apparent when the wound is first evaluated that partial hepatectomy or lobectomy will be required. It is this type of injury that taxes all the skills of the entire surgical team. Mortality is consistently high in this group (65 to 85 percent).

T-tube drainage of the common duct is acceptable in severe cases of hepatic trauma. This may help to decompress the biliary tree and, perhaps of greater value, offers an excellent means for later diagnostic study. T-tube decompression is not a substitute for adequate external drainage. If for some reason the common duct cannot be utilized, performance of a cholecystostomy may be considered. Neither T-tubes nor catheters should be removed prior to evacuation out of country.

The following guidelines are presented:

1. The midline abdominal incision usually provides adequate exposure.

2. Control of hemorrhage during resection can be facilitated by the use of hepatic inflow occlusion which can be safely utilized for 15 minutes in the normothermic patient or up to 1/2 hour in the hypothermic patient. The majority of patients with major trauma become hypothermic due to shock, cold fluids and air conditioned operating rooms. (Refer to section on Anesthesia and Resuscitation.)

3. The line of liver resection should be at the edge of devitalized tissue.

4. The use of packing as a means to control liver hemorrhage is not recommended except in extreme circumstances.

5. Injuries to the dome of the liver frequently involve the diaphragm which should be repaired in order to prevent biliary pleural fistula.

DUODENAL AND PANCREATIC INJURIES

Duodenum

The recommended treatment for duodenal injuries is:

1. Simple closure in small penetrating wounds without extensive injury to the duodenum or surrounding structures. Wounds edges must be debrided.

2. Resection and primary anastomosis when there is more extensive damage to the duodenum if it is technically feasible.

3. Serosal patching as a definitive procedure initially only when other forms of treatment cannot be safely utilized.

4. Pancreatoduodenectomy is to be used only for those cases in which the duodenum and pancreas are so severely injured that no other form of therapy is feasible.

5. If extensive loss of the distal duodenum precludes the re-establishment of duodenal continuity, Roux-Y anastomosis with the jejunum is indicated.

The majority of duodenal wounds which result from penetrating injuries of the abdomen are associated with other organ injury; principally stomach, liver, vena cava, pancreas and kidney. For this reason it is mandatory to examine the duodenum in all penetrating wounds of the upper abdomen to avoid missing this injury. This can be accomplished only by adequate mobilization of the duodenum by the Kocher maneuver. Adequate posterior dependent drainage is necessary in the management of these injuries. Use of duodenostomy tubes to protect the suture line is to be condemned. If a vent is indicated, passage of a catheter from the jejunum or stomach to the site of repair will prove to be effective.

Pancreas

The treatment of pancreatic wounds recommended by the study group is:

1. Debridement and drainage of the pancrease in those wounds not associated with extensive damage or disruption of the major pancreatic duct.

2. Resection and drainage for injuries in which there is maceration of pancreatic tissue, transection of the pancreas or disruption of the major pancreatic duct.

3. Pancreatoduodenectomy in those patients with such severe damage to the head of the pancreas and abdomen that no other procedure is feasible.

4. Pancreas should be examined in all upper abdominal injuries. The gastrocolic omentum should be divided so that the entire pancreas can be visualized.

5. Sump tube drainage is strongly recommended for use in pancreatic injuries in addition to Penrose drains. As with duodenal injuries, infection accounts for the majority of complications and most of these can be attributed to inadequate drainage.

RETROPERITONEAL INJURIES (SEE ALSO G-U SECTION)

Retroperitoneal injuries generally involve multiple organs and present difficult problems in management. In caring for such wounds the following recommendations are made:

1. Preoperative IVP to assess bilateral involvement and function if blood pressure is above 80.

2. Perforating trunk wounds should have exploration and debridement of the back wound prior to abdominal laparotomy whenever possible. (See section on Debridement.)

3. Explore retroperitoneal area by reflecting the gut. Check visually and manually.

a. Right side: Check head of pancreas, duodenum, vena cava, superior mesenteric artery, kidney, ureter and posterior musculature.

b. Left side: Tail of pancreas, transverse duodenum, aorta, inferior mesenteric vein, kidney, ureter and posterior musculature.

SMALL BOWEL INJURIES

Wounds of any portion of the small bowel require inspection of the entire bowel to avoid missing small single perforations. Small penetrating wounds may be closed in the usual fashion. However, multiple wounds and those with destruction of small bowel tissue within a relatively short segment are best managed by segmental resection and anastomosis rather than multiple separate wound closures. There have been increased anastomotic leaks with the use of everting anastomosis when utilized by surgeons unfamiliar with this procedure. The majority of the members of the study group recommended that only inverting anastomosis be utilized.

Thorough evaluation of mesenteric blood supply is mandatory prior to closure of the abdomen. Single loop vessel injuries may be ligated. However, multiple vessel damage and large areas of hematoma must be carefully evaluated and if there is a deficient blood supply to a portion of the bowel, resection and anastomosis at viable levels is mandatory.

In perforations due to typhoid, the segment of involved bowel is probably best managed by exteriorization.

RIGHT COLON WOUNDS

The morbidity and mortality of right colon wounds treated during the past year were reviewed. The recommendations are:

1. Isolated small penetrating wounds, 1 cm or less, with minimal contamination may be primarily closed after debridement when examination of the retroperitoneal space has been completed. Tube cecostomy with fixation of the cecum to the abdominal wall should be considered. The entrance wound may be used for the tube cecostomy.

2. A high incidence of complications (leakage, abscess) has been found after ileotransverse colostomy. Right hemicolectomy with ileotranseverse colostomy should be utilized only if there is minimal contamination and no associated organ involvement. Under less than ideal circumstances

ileostomy and distal mucous fistula must be performed. The same technique should be followed as in formation of a permanent ileostomy (masturation, appliance application, gutter space obliteration, avoidance of drain sites, etc.).

3. Exteriorization of the cecum and/or ascending colon should be avoided because of the mechanical difficulties encountered postoperatively.

Miscellaneous but associated problems:

1. Lesions of the right iliac bone associated with right colon injuries must be adequately debrided to include the fracture of the pelvis. If the acetabulum is involved formal hip joint exploration is indicated.

2. All types of wounds of the ascending, splenic flexure and descending colon should have adequate exploration of the retroperitoneal space to rule out additional lesions of the large bowel, ureter, kidney or other retroperitoneal tissue. In such instances drainage must be accomplished through a large incision in as dependent a portion of the flank as possible.

TRANSVERSE, LEFT COLON AND RECTOSIGMOID INJURIES

The principles of management of combat casualties with wounds to the transverse and left colon are well established and generally well followed.

It is recommended that with the exception of right colon injuries, as discussed previously, all colon lacerations must be treated as follows:

1. Exteriorization as an open loop colostomy is recommended for single colon injuries including contusions with potential breakdown. In all instances the colon must be opened as early as practical to afford decompression. This can be safely done within 24 hours after operation. Failure to open the colostomy is an invitation to disaster.

2. When exteriorization is not possible, repair and proximal colostomy is recommended. The colostomy should be constructed so as to truly divert the fecal stream and protect the distal repair. The functional end should be separated from the mucous fistula for a sufficient distance to allow appliance application. Unnecessarily wide separation is not recommended. Both ends should be matured. Sufficient mobilization should be obtained so as to avoid retraction or stretching of the mesentery causing vascular compromise. Obliteration of the gutter space may be used to prevent internal hernia.

3. For low sigmoid colon injury it may not be possible to bring out a mucous fistula. In such instances the distal segments should be closed and left in place.

4. Widely spaced injuries may be treated as in paragraph 2 by converting the proximal injury to a diverting colostomy. In unusual circumstances when distal repair is not feasible exteriorization of both sites may be required.

5. Repaired distal segments should be completely evacuated of feces by irrigation and lavage using anal dilatation to allow free egress distally. Generally this should be done at the operating table so that the distal repair may be observed and protected from disruption. The peritoneal cavity should be protected from additional soilage.

6. Colostomies and mucous fistulas should not be placed in laparotomy incisions or where soilage of drain sites will occur.

EXTRAPERITONEAL RECTAL INJURIES

Rectal injuries continue to cause unnecessary, frequent and extensive morbidity because:

1. Failure to recognize the injury.

2. Failure to completely divert the fecal stream.

3. Failure to provide free presacral drainage.

4. Inadequate cleansing of the distal segment.

5. Failure to remove foreign bodies.

6. Inadequate debridement.

The following principles and methods are mandatory to avoid the above occurrences:

1. A high index of suspicion must be present even when the wounds are remote from the perineal area and especially when fragments are seen on x-ray in the pelvic region. Digital and sigmoidoscopic examinations are mandatory and when evidence of injury is found laparotomy is indicated.

2. Diverting colostomy should be done as described under left colon injuries.

3. Debridement and primary closure of the rectal injury should be done if possible.

4. Free presacral drainage is essential to healing. Wide gentle development of the presacral space must be achieved which requires coccygectomy. The developed drainage area must communicate with the rectal injury. Sump and Penrose drains are recommended. Drains should not be placed through entry wounds or bone.

PELVIC INJURY (SEE SECTION ON GENITO-URINARY TRACT)

1. Adequate x-ray evaluation (to include IVP, cystourethrogram, etc.).

2. Assure urinary bladder drainage (for diagnosis of GU injury and urinary retention).

3. Assess extent of damage to other systems (especially rectum and GU system).

4. Debridement must be aggressive. At the time of initial debridement free bone fragments should be removed.

5. Be parepared for massive bleeding.

a. Although the bleeding may be primarily venous, ligation of one or both hypogastric arteries has on occasion proven helpful in establishing hemostasis.

b. Packing of the wound may have to be resorted to to control bleeding. It is recommended that the pack be impregnated with an antibiotic and removed in the operating room in 48 to 72 hours.

6. Redebridement in a few days may be necessary.

7. In severe wounds of the perineum with uncontrolled hemorrhage and damage to the rectum, abdomino-perineal resection may be the only means of controlling hemorrhage and obtaining adequate debridement of the area.

8. Pelvic wounds involving the hip and acetabulum should be exposed through the pelvis and the hip joint through a formal posterolateral hip joint incision which is left open after debridement.

TREATMENT OF LARGE ABDOMINAL WALL DEFECTS

Large abdominal wall wounds should be thoroughly debrided. If the resultant defect cannot be closed by local soft tissue, marlex mesh may be used even in the presence of contamination. A practical method for field use is to cover the defect with moist packs to prevent evisceration. Adhesions and granulations will form directly on the presenting abdominal contents which may then be skin grafted. Other foreign materials including free fascia lata grafts should not be used in the contaminated wound.

SPECIAL POSTOPERATIVE PROBLEMS

Stress Ulcer

This alarming and serious complication is most often associated with abdominal sepsis, burns and head injuries. Bleeding that results is often severe and unrelenting.

Approximately one-half the patients will respond to large bore gastric sump drainage, iced saline lavage, sedation, antacids and blood replacement. Large blood clots must be evacuated

before the stomach can be put at rest. When the bleeding has ceased, search for hidden abdominal sepsis should be done and treatment instituted. Consideration should be given to treatment with Atropine or Probanthine and Valium during or after bleeding.

As blood replacement approaches eight units, surgical intervention is usually necessary. Bleeding sites may be gastric or duodenal with most reports incriminating the stomach. Multiple bleeding sites commonly are found, sometimes presenting as shallow friable erosions scattered throughout the stomach.

Operative management must be tailored to the individual patient and consists of vagotomy and either pyloroplasty or partial gastrectomy with or without oversewing of the bleeding points.

Rebleeding after vagotomy and pyloroplasty may be expected in 20 percent of patients; and, if abdominal sepsis persists, the incidence of rebleeding is well over 50 percent.

Although vagotomy and resection is a more extensive procedure, the incidence of rebleeding is far less than with vagotomy and pyloroplasty. In the presence of abdominal sepsis, one should consider the hazards of additional operation for rebleeding. If the peritoneal cavity is clear and the stomach presents with multiple punctate bleeding points resembling erosive gastritis, then vagotomy and pyloroplasty might be considered first since the risk of re-operation is lessened.

Consideration should be given to anticipatory management of stress ulcers when repeated sepsis requires operative intervention. If the stomach is accessible and not involved directly in the septic process consideration should be given to placement of a gastrostomy tube which provides necessary decompression and allows easier lavage treatment of ulcerative bleeding should this occur.

Acute Acalculus Cholecystitis

This is an occasional consequence of nonspecific trauma occurring usually one to three weeks post-injury.

Hyperalimentation

Massive weight loss (20 to 30 percent TBW) in a two to three week period is frequently associated with extensive trauma, repeated operations, delayed healing and sepsis. When gastrointestinal tract function and absorption is not up to par, consideration should be given to early intravenous hyperalimentation. Although the weight loss and negative nitrogen balance may not be entirely corrected, the method may be of decided benefit in promoting healing processes, reducing weight loss and shortening the recovery phase. Urinary glucose spillage usually decreases spontaneously as tolerance develops.

See section on Anesthesia and Resuscitation for intravenous catheter care. This is the one exception where catheters are left in longer than is recommended. The method is reported in Annals of Surgery, June 1969.

I. General

At present, burn casualties are treated by resuscitation, debridement and application of Sulfamylon (mafenide) at the initial definitive treatment facility (e.g., evacuation hospital in Vietnam) and then transferred to an intermediate facility in the evacuation chain (e.g., Far East Burn Center, Camp Zama, Japan). At this point further treatment permits those with less severe burns to be returned to duty, and those with more extensive burns associated with full thickness skin loss to be further resuscitated and stabilized prior to evacuation to the long-term treatment facility in CONUS.

II. Resuscitation

A. Fluids: An estimation of fluid requirements is necessary as a guide for treatment in all burns. The Brooke formula is easily remembered and utilized in developing a plan for initial fluid administration. The fluids usually employed are Lactated Ringers, Plasmanate, five percent D/W, and Clinical Dextran. In major burns fluids should be administered through an indwelling catheter, preferably inserted into a central vein.

Brooke Formula

This applies to only the first 48 hours after the burn. Rule of 9s can be used to estimate the percent of body burn (use no more than 50 percent TBS for calculation).

First 24 hours: Lactated Ringers 1.5 cc X Kg body wt X % burn
Colloid 0.5cc X Kg X % burn
5% D/W:2000cc
1/2 is given in first 8 hours postburn; 1/4 each succeeding 8 hour period.

Second 24 hours: Lactated Ringers and colloid 1/2 to 2/3 of the above
5% D/W:2000cc

It cannot be overemphasized that the Brooke formula is only a guideline to therapy and not an iron-clad path to successful management. Patients who are dehydrated prior to sustaining their burn, those who have large areas of full-thickness loss, or those with serious associated injuries may require much larger volumes of fluid than anticipated by the Brooke formula. If additional fluid is needed during the first 48 hours, start with 1000cc 5% D/W, followed by Lactated Ringers and Colloid in the 3:1 ratio.

Except for patients with a traumatic source of blood loss or severe pre-existing anemia, whole blood should not be administered within the first three days, but may be required later in the postburn period. When available, blood-gas studies should be obtained to aid in the correction of acidosis, diagnosis of pulmonary complications and acid-base deficiencies.

After 48 hours post-burn, electrolyte-free water is required, and further administration of salt containing solutions should depend on demonstrated need.

Dehydration in the later postburn period is commonly due to large evaporative loss from the burn surface. Serum sodium levels above 136 are indicative of such dehydration as are rising hematocrits. (Sulfamylon artificially increases urine specific gravity.) Large volumes, six to eight liters, of electrolyte-free water per day may be required to replace such losses.

B. Urinary output: During the first 48 hours post-burn, the urine output is the best clinical guide to adequacy of resuscitation. An indwelling Foley catheter is necessary to monitor urinary output in burns over 20 percent TBS. When there is an early inadequate urinary output, inadequate volume replacement is almost always the cause rather than renal failure. The urinary output should be maintained at 40-60cc/hour. When the urine output falls below this level, the rate of fluid administration should be increased until the desired urinary output is obtained. When the output exceeds 100cc/hour during the first 48 hours, the rate of fluid administration should be decreased. Osmotic diuretics, mannitol, etc., are usually required only in those patients with large heme pigment loads or those with deep burns. During osmotic diuresis, the urinary output is not a reliable guide to fluid requirements (nor is it after the first 48-72 hours when spontaneous diuresis usually occurs). Renal failure when it occurs early can almost always be traced to inadequate volume replacement. In patients with associated crush injury or who have chemical burns where hemolysis is prominent, early renal failure may occur.

Renal failure is more apt to be a late complication of burns when it is usually a manifestation of sepsis.

C. Avoidance of respiratory problems:

1. Severely burned patients often develop ileus, especially during the first four days postburn. Oral feedings are withheld until there is good peristalsis. (When oral liquids are tolerated, IV fluid requirement is correspondingly less) There is a special hazard of fatal asphyxia from aspiration of vomitus when severely burned patients with ileus are air-transported. A nasogastric tube is strongly suggested during transportation of these patients.

2. Severe burns of the neck may result in tracheal compression from edematous tissue beneath an unyielding third degree eschar. In these patients, when there is any evidence of compression, tracheostomy is indicated. A burn of the face, neck or upper thorax is not per se an indication for tracheostomy.

3. Patients burned within an enclosed space, especially with burns about the face, may have inhalation injury. This is manifested by hypoxemia, bronchospasm, excessive bronchial secretions or laryngeal edema. Mild forms are treated by changes of position, humidification of inspired air, suction of the nasopharynx, and in the more severe cases by insertion of a nasotracheal or orotracheal airway. Tracheostomy is done in such cases not responding to the above measures or which require air evacuation. Tracheostomy should be done electively and under ideal conditions.

III. Wound care

A. Debridement: Unless there are associated injuries, debridement can be done in the emergency room or ward, and the use of general anesthesia at a time of rapid edema formation and diminished blood volume is decried. Such debridement can be done with minimum discomfort using intravenous analgesia. The body hair in the involved and immediately adjacent area is shaved. Loose, dirty, devitalized skin is removed, and the burned areas gently cleansed with a surgical detergent and rinsed well.

B. Topical therapy: A layer of topical Sulfamylon (mafenide) in water-soluble ointment form about 1/16 inch thick is then applied to the burns as the usual form of topical therapy. The patient is placed on surgically clean or sterile sheets. A cradle over exposed burn surfaces with overlying sheet increases patient comfort and provides some protection to the wound which is left exposed. The Sulfamylon is reapplied as needed when it is rubbed off. Otherwise it is applied every 12 hours. Once daily, the patient is placed in a tub of water and the burns inspected and debrided.

It is not absolutely necessary in the first 48-72 hours to remove the Sulfamylon. Simple reapplication at 12 hour intervals is permissable. Prior to aeromedical evacuation, adequate coverage of the burn with Sulfamylon is ascertained, and for ease of transport, dressings are applied. The easiest coverings to apply are NRC pads. If these are not available, sterile fine mesh gauze is applied and padded with 4 X 8 gauze or fluffs, and extremities can be wrapped with Kerlix in a loose non-constricting manner. The fingertips and toes must be left exposed to permit checking of circulation.

C. Escharotomy: May be required in circumferential third degree burns of the extremities or chest (rarely with deep second degree burns). The rare cases in which fasciotomy is required are deep burns or electrical burns where there is actual muscle tissue necrosis.

Indications: 1. Impaired respiratory movements from circumferential burn of the chest.

2. Cyanosis, impaired capillary filling and progressive neurological changes in circumferential burns of the extremities. Coolness and edema of distal unburned parts are normal in burn injury and are not indications for escharotomy.

Technique: 1. Incision along mid-lateral and/or mid-medial lines of extremities and along anterior axillary lines of the chest. The incision should carry across joint areas of increased constriction.

2. Incise throughout extent of third degree burn.

3. Whenever possible, avoid superficial arteries, nerves and tendons.

4. General or local anesthesia is not required since incision is through third degree burn (anesthetic area).

5. Incision is initially carried only through dermis and immediately subjacent thin connective tissue layer. This usually suffices. If blood flow does not improve, deeper incision through fascia may be needed.

IV. Antibiotics

Most major burns are given penicillin for the first seven days post-burn. This is to eliminate infection by Beta hemolytic streptococcus. After this period antibiotics are given only for specific indications of which urinary tract infection, pneumonitis, and septic phlebitis are the most common.

WHITE PHOSPHOROUS BURNS

A. Wounds should be irrigated with water or saline and covered by wet dressings to prevent re-ignition of particles.

B. Resuscitation is as for any burn.

C. Top priority should be given to debridement of white phosphorous burns with the total removal of all phosphorous particles.

D. At debridement small amounts of dilute (2%) copper sulfate dripped into the wound aid in identification of phosphorous particles. Removed phosphorous should be placed under water to prevent operating room fires.

E. Treatment is as for any burn after the phosphorous particles have been removed.

F. It should be emphasized that copper sulfate solution must not be left in contact with the wound since systemic hemolysis can result. Also, only fresh copper sulfate should be used since evaporation of water from old solutions can increase its concentration.

G. Serial calcium and phosphorous blood levels should be done with frequent EKG monitoring. Hypocalcemia resulting from increased phosphorous levels may lead to cardiac arrhythmia. This is managed by adequate oxygenation, an IV drop of 0.1 percent Xylocaine and IV calcium.

NOTES OF CAUTION

1. Anesthesia: Caution is necessary in giving a general anesthetic to a burn patient (See Anesthesia Section). Anectine + hyperkalemia = death!

2. Sulfamylon treatment: In event of significant acidosis the sulfamylon cream should be removed and therapy resumed 24 hours later.

3. Urine output: If urine output falls after the third to fourth day furosemide or ethacrinic acid should be relied upon rather than excessive volumes of sodium bicarbonate, Plasmanate, or mannitol to reduce the risk of acute pulmonary insufficiency.

4. Any patient who has inhaled white phosphorous fumes should be watched closely for severe pulmonary problems.

ORTHOPEDIC SURGERY

1. GENERAL

Preservation of life and limb depends on the wound and the surgeon. War surgery is a demanding experience requiring aggressive and meticulous attention to every detail of patient care under adverse conditions.

Orthopedic surgeons should utilize proper principles of debridement and are referred to that section of this document.

The orthopedic study section reiterates confidence in the principles described in the NATO Handbook, "Emergency War Surgery," with minor exceptions.

2. HAND INJURIES

a. Hand injuries usually carry a low priority. They are rarely life endangering.

b. Initial surgery is preferably done under tourniquet control with deflation after each 60 minute period for at least a 15 minute period with a second re-inflation not to exceed 45 minutes.

(1) DEBRIDEMENT: A minimal amount of the wound border should be excised, but a wide exposure of underlying tissue should be obtained with incisions consistent with principles defined in hand surgery texts but generally in the longitudinal axis. Debridement principles are applicable here as elsewhere. Only those portions of tendons which are damaged should be excised. Nerve damage should be thoroughly evaluated and described in the operative report. Overzealous debridement of nerve should be avoided. Nerve ends need not be tagged. Wide release of involved compartments of the hand and of the involved forearm is necessary. It is often necessary to incise the volar transverse carpal ligament to prevent embarrassment of the median nerve and the flexor tendons. Bone with soft tissue attachments should not be removed. Larger pieces of bone beyond finger nail size chips should be thoroughly cleansed and replaced.

(2) Kirschner wires may be used in initial surgery to maintain metacarpal spacing, metacarpal length, the normal arches of the palm or unstable joint reductions. The wire ends should be buried if possible. Kirschner wires also may be placed at time of delayed primary closure.

(3) X-rays in two planes should be made before and after the initial surgery.

(4) Copious irrigation of the hand wound is indicated prior to dressing.

(5) The tourniquet should be released and bleeding controlled prior to dressing the wound.

(6) The hand wound is not an exception to the open wound treatment and delayed closure techniques. Hand wounds are therefore left open and dressed as are other wounds with fine mesh gauze in a single layer and fluffed gauze, carefully avoiding packing that might occlude drainage. Tendons and nerves left exposed in the wound should be covered with thin strips of wiped vaseline gauze or Adaptic to keep them moist and should not be repaired.

(7) Plaster splinting over massive bulky dressing should be applied to maintain the functional hand position. All finger joints including the MP joint should be in mild flexion, and the thumb should be abducted and facing the pulp of the long finger. The wrist should be in mild extension.

(8) All hand wounds should be evacuated in bivalved long arm casts and generally should be evacuated as litter patients as this greatly facilitates hand elevation and decreases edema through the evacuation chain.

(9) Physical therapy instructions on the movements of the hand and shoulder should be given to the patient prior to evacuation.

c. ANTIBIOTICS: Prophylactic antibiotics are recommended in treating all wounds of the joints, bones, large soft tissue wounds, and severely contaminated wounds. In smaller wounds that are relatively clean, usage of antibiotics is at the discretion of the treating surgeon. Penicillin in large doses is recommended, and broad spectrum antibiotics may be used at the discretion of the surgeon. Wound cultures and recultures should influence the subsequent

antibiotic usage. (Refer to antibiotic section.)

d. WOUND CLOSURE

(1) Primary closure of hand wounds is not indicated.

(2) Delayed primary closure should be done at 3-7 days if the wounds are clean on inspection and can be closed without tension.

(3) Redebridement of dirty or non-viable tissue will defer closure.

(4) After 10 days the skin edges will become fixed. Undermining should be avoided. If the wound is clean, split thickness skin grafts should be done without hesitation. Mesh grafts are acceptable.

(5) There is no place for pedicles, rotation flaps, or skin transposition in this early stage of treatment. Failures create insurmountable handicaps to future reconstruction.

e. Elevation of the wounded hand above chest level should be continuous until there is no evidence of edema. Elevation during evacuation is facilitated by the long arm cast that is bivalved. Simple pillow elevation should not be used. Hands that are evacuated in simple splint immobilization or in bulky dressings frequently are tied up for elevation. This quite commonly shifts the dressings and the patient is uncomfortable en route. This should be avoided.

f. Active finger motion as permitted should be encouraged within the dressing with pain as the limiting guideline.

g. Observation of finger tip circulation should be frequent. Circular dressings should be released at any sign of circulatory embarrassment.

h. SPECIAL CONSIDERATIONS

(1) Nerve repair at initial surgery is not indicated in combat wounds, and should be deferred until well after a clean, closed and uncomplicated wound state has been obtained. Tagging of lacerated nerve endings is controversial.

(2) Exposed tendons lying in good tissue beds need not be covered initially. Skin grafts may take over exposed tendons if they have remained viable, but delayed primary closures or skin grafts should not be done over darkened, degenerated, non-viable tendons. These must be redebrided.

(3) Vascular repairs of a single vessel at the wrist or distal to the wrist should not be attempted. Exposed vessels are the only indication for tissue shifts, not to include the skin.

(4) All tissue should be preserved at the most distal level of viability. It is often possible for instance that a finger damaged beyond salvage could contribute viable skin useful in delayed coverage in the palm or dorsum of the hand.

3. FOOT INJURIES

a. The foot is particularly prone to serious injury from mine explosions as well as the usual gunshot or fragment injuries.

b. Initial surgery consists of thorough debridement, which will usually require plantar incisions (that are avoided in other circumstances) as well as dorsal, medial or lateral exposures as required by the wound. Again incisions in the long axis are desirable except under the metatarsal heads where a transverse incision distal to the ball of the foot will provide the required exposure.

(1) Unstable fractures or dislocations may be transfixed with Kirschner wires as in the hand section.

(2) Attached bone fragments should be left in place. Larger detached fragments should be cleansed thoroughly and replaced.

(3) Dressings are applied as in the hand with fine mesh gauze and gauze fluffs avoiding tamponade of the wound.

c. X-rays should be made in two planes before and after the procedure.

d. Circular casts should be used for immobilization and bivalved. Plaster splints are not adequate. Neutral position of the foot and ankle is required except when the Achilles tendon mechanism has been disrupted, in which case, moderate, not severe, plantar flexion is permitted.

e. Elevation should be continuous.

f. Active toe function can be permitted within the limits defined by pain.

g. Frequent observation of circulation in the toes should be made and circular compression released at any sign of embarrassed circulation.

h. Wound Closure

(1) Primary closure is not indicated.

(2) Delayed primary closure can be done at five to seven days on the dorsal surface only, if the wounds are clean and if suturing can be done without tension and dead spaces are not created. Delayed primary closure of the plantar surface of the foot should not be done.

(3) Debridement of dirty and/or non-viable tissue will defer closure.

(4) After 10 days the skin edges will become fixed. Undermining should be avoided. Split thickness skin grafts should be done without hesitation if the wound is clean.

(5) There is no place at this early stage of treatment for pedicles, rotations or transposition of skin to provide coverage.

i. Special Considerations

(1) Nerves should not be repaired. Their repair should be left for later consideration in the presence of a clean, closed and uncomplicated wound.

(2) Tendons should not be repaired in this stage of treatment. Management of exposed tendons is described under the hand.

(3) Vascular repairs distal to the calf are not indicated. Exposed vascular structures should be covered by soft tissue shifts, excluding skin.

(4) Rather devastating closed injuries of the foot will also be encountered from crush or from mines exploding beneath vehicles. Massive swelling ensues and ischemic contractures are a potential complication unless decompressive fascial incisions in the foot and frequently in the calf compartments are performed.

4. AMPUTATIONS

a. All attempts should be made to save a viable limb.

b. Massive injuries, particularly with an unsalvageable vascular injury, are better primarily amputated.

c. Initial amputations or amputations done for misjudged viability, failed vascular repairs, or massive distal infection should be done at the lowest level of good skin and underlying tissue. Open circular amputation is the most acceptable amputation. The skin is incised circularly and allowed to retract, the muscle is severed at the level of the skin retraction, and the bone is severed at the level of the muscle retraction. There are, however, a significant number of cases where there is good viable skin and underlying soft tissue distal to the sensible level of bone amputation in which it is advisable to save the viable skin and soft tissue in flaps for use in subsequent closure of the stump. Plastic surgery principles of the viability of flaps should be respected and over-lengthy flaps avoided. Profound surgical judgment must be exercised in these decisions. Bleeding should be controlled prior to dressing.

d. Definitive Syme amputations should not be done in theater, only the first stage Syme amputation (an ankle disarticulation with preservation of the heel pad). It is anticipated that second stage Syme amputation would be done later on.

e. Technique of application of skin traction (See figures 1 through 4)

(1) As a general rule, in above knee amputations the skin adhesive and stockinette should not be applied more proximally than six inches from the edge of the amputated skin. The ace bandage should be to this height only. Other dressings may be placed higher. This, therefore, allows a pull that is directed largely at the distal ends of the stump and gives a much more effective closure by skin traction methods. The amount of weight applied to an AK stump varies from six pounds to four pounds. The rule for below knee and upper extremities (below elbow and above elbow) varies between three and four inches and between two and four pounds of weight according to the size of the individual and the stump. For purposes of transporting the patient in self contained traction devices, great care must be utilized in the application of the plaster and the wire ladder splint outrigger. In the case of below knee stumps the proximal counterpoint of the cast pressure should be the ischial tuberosity. In above knee amputations it should be a spica cast unless the spring loaded device is available. (This is now a standard item and can be ordered through routine channels.) In the upper extremity a long arm cast for below elbow amputees with the elbow flexed at 90 degrees is adequate. For above elbow amputees a shoulder spica cast must be the stabilizing point for the traction device. Frequently the ends of the stump are markedly edematous and frequently there is skin slough as a result of a choking effect proximally from a circular cylinder. The dressings should not be packed in so tightly against the stump end that they occlude drainage and they should be changed as needed.

(2) Traction should be maintained as continuously as possible as the success of the open circular amputation technique depends upon continuous traction application. However, there will be some exceptions to this rule. In flights of short duration, traction might be released for a few hours at a time and then re-applied at the termination of the air flight. Occlusive constrictive wrappings at and around joints should be avoided.

f. Amputations with preserved oblique or otherwise unusual flaps require individualized dressing considerations. The flaps should be held in their intended positions by the dressings and the major area of the amputation should be left open and dressed with fine mesh gauze. Frequently the amputated stump can be treated with skin traction glue attached to a portion of the end of the stump without putting unnecessary traction upon the abnormally shaped flaps. There is no indication for definitive bone preparations in the initial surgery such as removing articular condyles, etc. This will be done at a latter procedure.

g. Stump Wound Closure

(1) There is no indication for delayed primary closure in open circular amputations and fingers and toes. Continued traction will often result in the skin eventually closing over the end of the stump. If it does not, small split thickness skin grafts can be used. A definitive revision will later be necessary but it can be done under conditions permitting immediate fitting techniques or more rapid prosthetic application. Delayed primary closure too often results in a chronically inflamed edematous, indurated, and sometimes draining stump that is chronically unreceptive to prosthetic application and is associated with a high infection rate.

(2) In amputation in which flaps are preserved, full closure of the stump at time of DPC is not the goal and rotation or shifting of other skin to get full closure at time of DPC is contraindicated as this carries an extremely high failure rate, based on past experiences. Successful cases may be reported as a tribute to surgical skill, but unsuccessful cases here are catastrophic, resulting in a higher level of amputation. The goal in preserving flaps at time of initial debridement is to prevent higher levels of amputations. It is questionable that these maneuvers really speed up the prosthetic application. It should be emphasized that the main basis for flap preservation is to salvage length that might be sacrificed in a rigid open circular policy. Ill advised early closure of any amputation stump threatens length when it fails and usually results in a chronically unreceptive stump for prosthetic application.

h. Transportation

(1) Traction should be continuous throughout the evacuation process whenever possible.

(2) The self contained traction device incorporated in cast using a wire ladder splint, etc., as explained under the technique of skin traction is sufficient for transporting the patient en route.

(3) The self contained constant friction traction unit is now available as a standard item and should be ordered through unit supplies. Great care must be utilized in using this as it must be attached to the foot of the litters and patients must be instructed not to slide down on litter

to release traction effect.

i. Antibiotics (See antibiotic section under paragraph 2c)

5. PELVIC FRACTURES

a. Penetrating injuries involving the hip area, pelvis and lower abdomen are a combined general surgical, urological and orthopedic problem. When the hip joint is involved even without an external wound about the hip, a formal arthrotomy is required as discussed in paragraph 6.

b. Loose bony fragments of the pelvis should be removed. Ureteral injuries should be internally splinted by catheter. A diverting nephrostomy may be done. Bowel injuries in this area are discussed in the General Surgical Section. A diverting colostomy is indicated. Coccygectomy may be required for drainage of wounds in the extra-peritoneal rectal area. This general class of injuries is among the most threatening that orthopedic surgeons assist with. Without careful attention to these requirements, severe sepsis and death are highly probable.

c. Closed pelvic injuries are treated as they might be in civilian life with attention to GU involvement, ileus and shock from hidden hemorrhage.

6. WOUNDS INVOLVING JOINTS

a. All penetrating or perforating wounds of joints should, after careful general evaluation and resuscitation, be x-rayed in two planes as a baseline, followed by early formal arthrotomy under tourniquet where practical. This should include a thorough debridement of the joint with removal of foreign material, bone chips, blood and other devitalized tissue. This should be followed with copious irrigation. Synovial or capsular structure should then be loosely closed and the skin wound left open for delayed closure. No drains or irrigating catheters should be used at this stage. All penetrating hip wounds should include a posterior arthrotomy and drainage. Routine war wound dressings as previously described should be applied, and the joint immobilized by a bivalved circular cast. Prophylactic antibiotics should be routine. At five to seven days, if the wound appears clean without evidence of intra-articular inflammation, delayed primary closure can be performed.

b. Cases will be seen wherein capsule and synovium are destroyed to the extent that closure is not possible and after appropriate debridement, the wound must be dressed in the normal manner with the joint open. Flaps and skin transpositions should not be done at this time. The salvageability of such a joint in terms of motion must be suspect, but surprisingly, synovium has rapid recuperative powers and will often cover the defect, to be in turn covered with healthy granulations receptive to split thickness skin grafts, leading to a functioning joint. Complete original debridement is probably the key in the successful outcome in such cases.

c. Sepsis in a joint can result in rapid destruction of the joint. Early recognition is mandatory. Persistent swelling, marked pain, local warmth, temperature elevation, intense pain on any motion are indicative of the requirements for a repeat formal arthrotomy with a thorough joint toilet and loose closure of synovium only to protect the articular surfaces; DPC of the wound can be performed later. Rubber drains should not be used. Gravity drainage postoperatively by turning the patient frequently in the prone position or other positions dictated by the wound are necessary in this treatment. It is not recommended that tube irrigation of the joint be performed with such solutions as neomycin as the frequent occurrence of deafness is a greater handicap than is loss of a single extremity. It is emphasized that repeat joint toilets and debridements frequently are necessary in this type of wounding.

7. FRACTURES

a. The initial management of open fractures in combat includes thorough debridement, removal of all foreign material and devitalized tissue, and opening of damaged fascial planes. The surgeon is referred to the section on debridement.

b. Fracture Management

(1) Biplanar x-rays are required initially.

(2) There is no place for internal fixation of open war wound fractures.

(3) Small fingernail size detached fragments should be discarded; but larger fragments, particularly those contributing to length and circumferential integrity, should be retained.

Loose fragments should be thoroughly cleansed and repositioned.

(4) Primary closure over fracture is never indicated. Delayed primary closure under tension over fracture should not be done. It would be be better to aim for closure by split thickness skin graft. When delayed primary closure is done over a fracture it should be watched carefully for signs of inflammation. Any hint of infection should be countered by immediate opening of the wound. It is this sort of penned up infection that results in the chronic osteomyelitis so troublesome to everyone. Wounds left open over fractures may drain or weep for a long time but they seldom cause chronic problems.

c. There is absolutely no place for flaps or tissue shifts of any kind including relaxing incisions in the early treatment of wounds over fractures. The goal with these wounds should be closure by DPC or coverage with split thickness grafts. Failed flaps or lost relaxed segments may forever handicap future reconstructive efforts. Unsatisfactory skin grafted or scarred areas can be replaced later with much less risk.

d. Casting

(1) Plaster slab splinting is inadequate except in controlled hospital circumstances for wound dressing purposes and even then is rarely useful.

(2) A circular plaster cast should be applied and bivalved using two or three darts on each line of plaster saw cut (figure 5). The darting technique prevents sliding between the two halves of a bivalved plaster cast in transit. Monovalved casts are indicated only in the controlled hospital circumstances for relief of swelling. For the purpose of the early management of these injuries through phases of initial treatment and evacuation, there is no place for a monovalved cast. A case retained for whatever reason to a point where his condition, including his fracture is stable, can be transported with an intact cast. Any hint of instability with particular reference to swelling and circulation should require bivalving of the cast. A history of vascular injury requires a bivalved cast and windowing over the area of vascular repair. The decision at this level should be the responsibility of the dispatching physician. No patient in a cast should be sent for evacuation without adequate observation post-casting to certify the quality of the cast. This normally means 48-72 hours.

(3) Plaster casts should be marked with identifying information for the use of receiving and transportation personnel.

e. Special Considerations

(1) Vascular injuries do not require internal stabilization of underlying fractures. Resultant infection would threaten the integrity of the vascular repair more than anything else. Careful casting should suffice. Occasionally, rongeuring of sharp pointed spicules threatening the vascular repair is necessary. Bivalved casts with windows in the area of the vascular repair should be used throughout the process of evacuation.

(2) Brachial artery injuries with fracture should be transported in a Velpeau type dressing strapped across the chest. Coincident thoracic injuries should be resolved before evacuation.

(3) Spica casts should be constructed to avoid width beyond that of a standard litter for ease of evacuation. Threaded Steinmann pins are preferable for incorporating in plaster casts as opposed to small Kirschner wires which are noted to bend en route. The incorporation of traction bows in the plaster casts should be discontinued and is unnecessary if small threaded Steinmann pins are utilized.

(4) Ischemia from swelling in muscle compartments distal to arterial repair can be relieved only by fasciotomy. In the popliteal or lower femoral area a plea is made for immediate fasciotomy of all compartments below the knee if conditions permit. In this particular circumstance,waiting for symptoms develop prior to fasciotomy results in unsalvageable function that might have been saved by earlier fasciotomy. The method of calf fasciotomy, two incisions versus fibular resection, is immaterial as long as all three compartments are opened and the full depths of the compartments are released.

(5) Fractures of the humerus with or without combined chest injuries should not be evacuated in collar and cuff or in hanging arm casts. The hanging arm cast is an immobilization method for treatment and not for evacuation. The fractured humerus should be evacuated in a shoulder spica cast with liberal cut-outs as necessary for treatment of associated chest injuries and the cast should be bivalved with darts as in other bivalved casts. In applying shoulder spica

casts it is well to keep this within the width of the standard litter used in evacuation, which is 22 inches.

8. TENDON INJURIES

a. Open injuries of major weight bearing tendons such as the Achilles or quadriceps should be treated as other wounds without repair of the tendon. The Achilles tendon might heal satisfactorily with fixed plantar flexion of the ankle joint, but in general these are problems of late reconstruction.

b. No primary tendon repair is indicated in the combat zone no matter what the source or type of injury. The wound should be managed by staged techniques already described with the goal of obtaining a non-reactive, closed wound state. Debridement should include all destroyed and contaminated tissue and temporizing because of aversion to removing important tissues will result in failure of the debridement.

c. Proper position in splinting and casting is extremely important. The reader is referred to the sections on hand and foot injuries.

9. NERVE INJURIES

a. It is well documented that nerve injuries incurred in combat are best treated by delayed repair. In a wound that has been staged through DPC without any hint of complication throughout the postoperative course, the nerve repair might be instituted as early as three weeks after initial injury. In most cases the time involved will be longer than that, but in any case nerve repair should not be attempted until a clean closed wound has been attained and all tissue reaction has resolved. A non-reactive, soft, pliable bed for the nerve repair is desirable.

b. A full description of the nerve injury as observed by the original treating physician at debridement is of immense value to those treating the case subsequently.

c. Causalgia may be aborted by vigorous early conservative measures consisting of early function, physical therapy, electrical stimulation and anesthetic blocks. Persistent causalgia may require sympathectomy but this should be a later consideration in the management of the patient.

10. SOFT TISSUE INJURIES

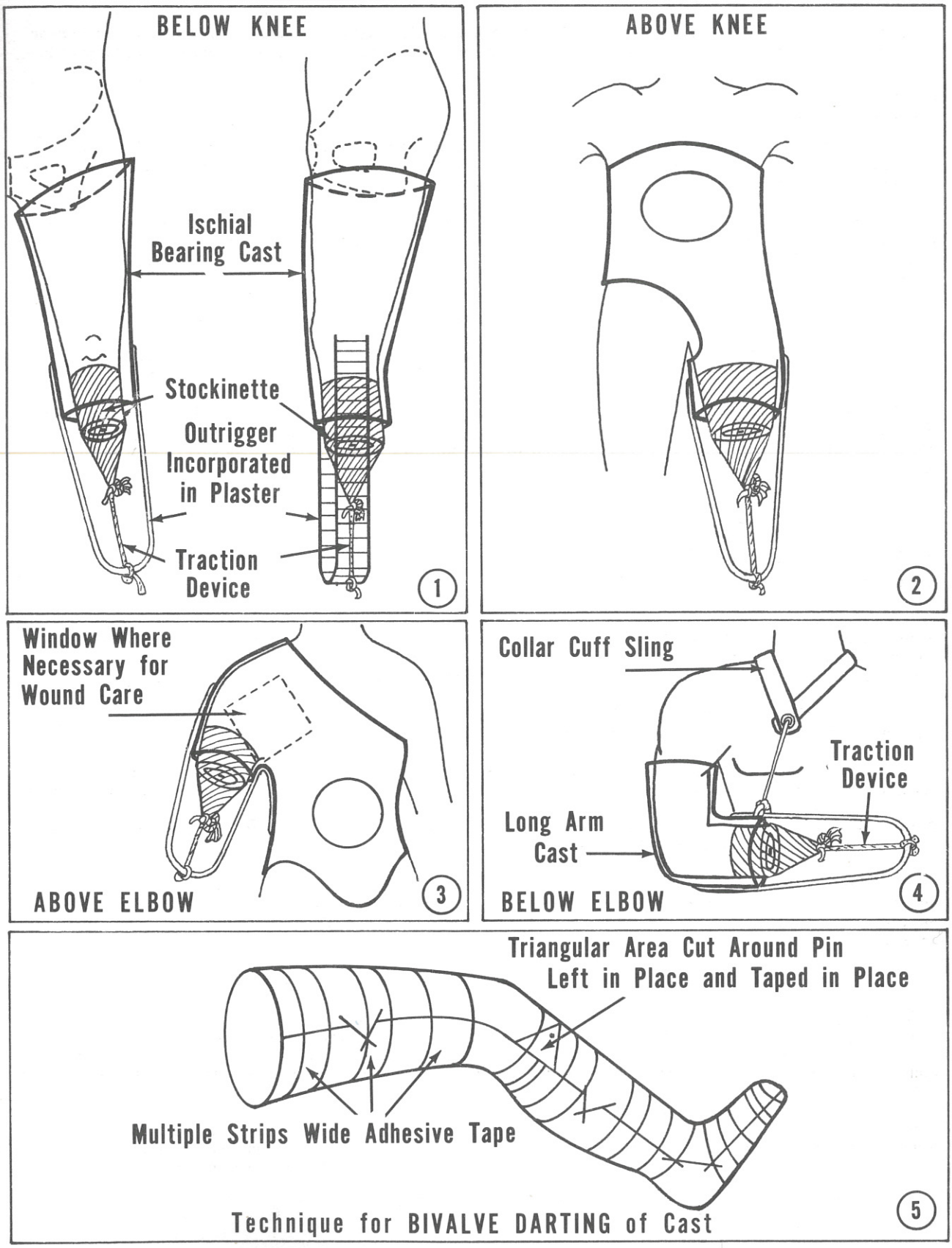
a. The usual principles of debridement, etc., apply here.

b. After the wounds are properly dressed, it is generally better to immobilize soft tissue injuries by plaster application; and for purposes of transportation, they should be bivalved in the usual manner. This prevents contractures in and about joints which have been seen from soft tissue wounds not immobilized in plaster casts.

11. DISLOCATIONS

a. All dislocations either open or closed should be reduced as emergencies and adequately immobilized following reduction with follow-up x-rays through plaster to assure that reduction is maintained.

b. Those dislocations that require open reduction under combat situations where there are associated wounds should be handled as open joint wounds and should not be primarily sutured following the open reduction.


BELOW KNEE
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1
ABOVE KNEE
2
Window Where
Necessary for
Wound Care
ABOVE ELBOW
3
Collar Cuff Sling
Traction
Device
Long Arm
Cast
BELOW ELBOW
4
Triangular Area Cut Around Pin
Left in Place and Taped in Place
Multiple Strips Wide Adhesive Tape
Technique for BIVALVE DARTING of Cast
5

GENITOURINARY TRACT WOUNDS

INTRODUCTION

Genitourinary injuries are frequently associated with multiple organ involvement. In caring for urological wounds, the following recommendations are made and supersede previous recommendations of the War Surgery Conference.

GENERAL CONSIDERATIONS

1. Hydration, as necessary to maintain a 24 hour urinary output of at least 2000 cc, is extremely important in patients with any type of catheter or splint in the urinary tract in order to reduce encrustation and abolish the necessity for irrigations.

2. All splints and catheters should be securely taped and/or sutured in place near the point of exit. The urethral catheter should be taped in place on the lower abdominal wall. This prevents pressure at the penoscrotal angle and reduces the incidence of urethral stricture, pressure, necrosis and fistulae.

3. All catheters should be connected to closed sterile drainage systems.

4. Patients with significant abdominal trauma should have an indwelling catheter inserted at the time of initial triage. This should be left in place until it may safely be removed.

5. All patients with catheters in place should be treated with antibacterials such as sulfonamides, nitrofurantoin, or mandelamine to suppress infection. Specific antibiotics should be reserved for complications or sterilization of the urinary tract after catheter removal. Acid urine is optimal.

6. Use absorbable suture on all urinary tract repairs, placing suture external to urothelium if possible.

7. Strict bed rest and vigorous hydration are of utmost importance in the conservative management of urinary tract bleeding following trauma.

8. Suprapubic cystostomy tubes should be placed in the dome of the bladder and angled in a cephalad direction emerging from the skin five to 10 cm above the symphysis pubis. Suprapubic tubes should be at least size 28 French to facilitate irrigation of clots. They should be replaced immediately if unintentionally removed. Probanthine may help relieve bladder spasms.

9. All urinary tract wounds should be generously drained. Drains should be secured by suture at the skin edge, and by safety pin to prevent retraction within the wound.

10. Urethral catheters should be large enough to drain urine and small enough to permit drainage of normal urethral secretions around the catheter. A meatotomy may be needed to enhance urethral drainage. A catheter no larger than size 16 French is advised. A larger size up to 24 French may be needed during episodes of bleeding to enhance irrigation and clot removal. After bleeding subsides the smaller size tube should be inserted.

11. Secretions around catheters and at the urethral meatus must be cleaned off with a neutral solution such as hydrogen peroxide and the urethra lubricated with an antibiotic ointment such as Bacitracin ointment. Cleansing of genital wounds and catheters should be performed several times daily.

12. Foreskins must be kept in the reduced position to prevent paraphimosis.

RENAL INJURIES

1. Nonpenetrating renal injuries can frequently be treated without surgery, but surgery may be required in the more severe injury.

a. Non-surgical management

(1) Diagnosis

(a) History of blunt trauma

(b) Finding of gross hematuria

(c) IV pyelography using 1cc of hypaque per pound body weight diluted with an equal amount of normal saline should be used if possible. One or two ampules of Mannitol (12.5 to 25 gm) may be added as an adjunct to enhance renal output and give better visualization. This may be done at the initial time of triage.

(2) Treatment

(a) Strict bed rest for ten days or until significant microhematuria clears.

(b) Gradual ambulation with monitoring of urine for recurrence of hematuria; the presence of which dictates resumption of bed rest.

(c) Blood transfusion may be required; need for more than two units suggests need for exploration.

(d) Patient should not be returned to combat zone duty for at least 30 days after healing because of danger of delayed rebleeding.

b. Surgical Management

(1) Diagnosis

(a) After history, physical examination and pyelography as above, exploration is indicated for:

1. Expanding flank or abdominal mass.

2. Continuing hemorrhage requiring two or more units of blood.

3. Significant extravasation of urine (Urine extravasating into hematoma will create a severe phlegmonous reaction and sepsis requriing operation and usually nephrectomy or partial nephrectomy.).

4. Arteriography and retrograde urogram are adjuncts to diagnosis which will probably be unavailable in the war zone.

(2) Treatment. Surgical management of blunt trauma is the same as for penetrating renal injuries [(2)(b) below].

2. Penetrating renal injuries should be explored and are usually associated with other abdominal injuries requiring exploration.

a. Diagnosis

(1) Suspicion of renal or urinary tract injury should be aroused in all injuries whose path may have traversed the urinary tract.

(2) Intravenous pyelography using high dose technique as noted above is essential before surgery to:

(a) Assure that a contralateral kidney is present if nephrectomy is required on the side of injury.

(b) Assess the damaged kidney and determine relation of foreign bodies to the urinary tract.

(3) Inject contrast material during triage so that pyelograms can be obtained with initial x-ray examinations.

b. Surgical Principles

(1) Anterior midline approach is usually dictated by associated injuries and affords access to both renal pedicles.

(2) The renal vessels should be located and controlled with vascular nooses or

vascular clamps prior to opening Gerota's fascia and losing its tamponade effect. The renal artery may be occluded up to 20 minutes without renal damage. Intermittent occlusion may be necessary for longer periods under extreme circumstances.

(3) Reflect the colon medially and open Gerota's fascia laterally to assess the injury only after vascular control has been established.

(4) Nephrectomy is performed for avulsion of the renal pedicle, shattered kidney, loss of more than 50 percent of parenchyma, or uncontrollable bleeding.

(5) Renal lacerations should be debrided of necrotic tissue. Arterial bleeders should be suture-ligated with chromic catgut. Penrose drains are essential.

(6) If partial nephrectomy is performed, the capsule is stripped from the portion to be resected. The knife handle is used to divide parenchyma, and vessels are suture-ligated with fine chromic catgut. The collecting system is closed with catgut. Capsule is used to cover the raw surface if available. Multiple or large extraperitoneal drains are essential and should be maintained for up to 10 days to insure drainage of any urine leakage or hematomata. These should be brought out through a stab wound in the flank posterolaterally.

(7) Bedrest may be necessary for up to three weeks to avoid late bleeding.

URETERAL INJURIES

Ureteral injuries will be missed unless suspected and preoperative pyelography with adequate amounts of contrast material is performed. Intravenous injection of 5cc indigo carmine or 10cc methylene blue at surgery will help demonstrate ureteral leaks. Ureteral injuries should be debrided and repaired primarily without tension using fine chromic catgut. Avoid simple circumferential scars which lead to stricture. Use oblique suture lines and spatulate both ureteral ends. Retroperitoneal drainage is essential but drains should not lie against the suture line. A #6 to a #8 French splint should be used. This may be brought out with a pyelostomy or nephrostomy tube, or may be inserted up the ureter and brought out with a suprapubic cystostomy tube. As a rule urinary diversion should be used as noted above. Nephrostomy tubes should vary in size from #22 to #28 French units using a Malecot catheter if possible. This must be anchored securely to the skin. This is the most reliable form of proximal diversion and may be replaced if necessary. It should be considered in all wounds of the renal pelvis and of the ureter above the bony pelvis.

Injuries of the ureter within the bony pelvis may be reimplanted obliquely into the bladder trigone, without tension and with a ureteral catheter splint-diversion extending to the renal pelvis, and with drains at the anastomosis. A suprapubic cystostomy tube should be used.

Massive unilateral ureteral trauma with a normal opposite kidney and ureter, particularly if fecal soilage or other factors are present, is usually best treated with a nephrectomy. Attempts at repairing such a ureter often result in severe postoperative complications and eventual fatality.

A nephrostomy is indicated in handling a solitary kidney with associated large ureteral defect. No attempts should be made to use intestinal conduits or transureterostomies in a combat zone or in the initial treatment of abdominal trauma.

Tube pyelostomies and ureterostomies are discouraged because of instability, tendency to obstruction, and the difficulty involved in replacing them if they are dislodged. Splints and tubes should be maintained until the patient is under urological care.

Elective ureteral surgery and stone surgery should not be done in the war zone. A patient with an obstructing calculus who is not septic may be considered elective and evacuated to urological care.

BLADDER INJURIES

1. Diagnosis. Hematuria, cystogram (filled, oblique and postevacuation films) demonstrating intra- or extra-peritoneal extravasation.

2. Treatment

a. Urethral catheter may be left in place until repair is accomplished, then removed.

b. Close lacerations with one or two layers of chromic catgut and place a midline suprapubic cystostomy with a size 26 to 32 Franch Malecot catheter near bladder dome.

c. The space of Retzius should be liberally drained.

d. Irrigation as necessary for postoperative bleeding.

e. The use of sump drainage and coccygectomy are usually necessary in massive bladder trauma to allow adequate drainage.

f. Debridement of loose bone must be done. Associated colostomies should be irrigated with neomycin or similar cleansing solutions. Associated pelvic fractures and bladder wounds usually require debridement.

URETHRAL INJURIES

1. Diagnosis

a. Bloody urethral discharge

b. Retrograde urethrogram using contrast material and water soluble jelly in equal amounts.

c. Inability to pass a catheter.

d. Inability to urinate after trauma.

2. Treatment principles

a. Suprapubic diversion.

b. Adequate debridement of penetrating wounds and major crush injuries.

c. Except for minor lacerations most major urethral injuries should be exteriorized with suture of the urethral margin to the skin using chromic catgut. Reconstruction can be done later.

d. Adequate drainage.

e. Associated rectal injuries treated with diverting colostomy, cleansing of distal colonic segment, and, if indicated, coccygectomy to enhance dependent drainage. The use of sumps is encouraged.

f. Transection of the membranous urethra associated with pelvic fractures should be treated with suprapubic exploration. A Foley catheter with a large balloon, if possible, should be used to restore urethral continuity and to provide slight traction. Bolster sutures in the prostatic capsule brought through the perineum and tied over dental roll or similar small pads will hold the prostatic urethra in position. Perineal explorations should be reserved for those patients with bony fragments in the urethra and should not be routinely done. A suprapubic tube should be left in the bladder. Traction on the urethral Foley should be in the range of 1/2 to one pound and this is best done by bringing the catheter up over the patient's chest to provide a smooth urethral angle and avoid pressure between the scrotal junction. Excessive traction will damage the sphincter and urethra. Traction should be maintained for two weeks. Antibiotics should be used. Urological consultation and follow-up is mandatory in the rehabilitation of these patients. All efforts are made to prevent incontinence, stricture and impotence.

PENILE INJURIES

1. Tourniquet may be applied for ten minutes intervals to facilitate debridement.

2. Debride conservatively.

3. Buck's fascia should be closed with interrupted chromic catgut to prevent herniation of erectile tissue.

4. The glans penis can be debrided and closed primarily.

5. Skin closure of the penile shaft may be primary if the wound is clean. Delayed primary closure should be used if there is any question.

6. The denuded penis should have a protective dressing and evacuation to urological care.

7. In the event of massive wounds, suprapubic cystostomy may be needed.

SCROTAL WOUNDS

1. Penetrating scrotal wounds should have exploration and debridement.

2. In testicular wounds, conserve as much viable testis tissue as is compatible with closure of the tunica albuginae. If no scrotal skin is available, bury the testicle in the soft tissues of the abdomen or thighs.

3. Drain all scrotal injuries with dependent drains.

4. Scrotal wounds can be debrided and closed primarily unless grossly contaminated.

5. A pressure dressing of fluff gauze and elastic bandages will reduce swelling and discomfort. After 24 hours this may be replaced with gauze and a scrotal support.

UROLOGICAL CARE OF THE ACUTE NEUROGENIC BLADDER

1. Suprapubic cystostomy is rarely necessary at the initial stage of treatment. Use a #16 French Foley catheter with scrupulous catheter care. Catheters should be changed every seven to 14 days or more often if indicated by obstruction, infection or encrustation.

2. Straight closed system catheter drainage is preferred. Tidal drainage and intermittent clamping are unnecessary and to be avoided. If fluid is adequate, irrigations can be eliminated.

3. Urinary antiseptics are recommended, such as sulfonamides, nitrofurantoin, Mandelamine, ascorbic acid, may be used to acidify the urine. Antibiotics are reserved for complications.

4. Tape the catheter to the abdomen to avoid pressure necrosis at the penostrotal angle.

TESTIS TUMORS

Tumors of the testis are the most common malignancies seen in the military age group. They masquerade as a variety of more benign conditions and often deceive the unwary physician. Any intrascrotal mass which cannot be excluded from the testis on examination should be considered to be a testis tumor and referred to urological care with the greatest urgency. We strongly urge that tumor surgery not be done in the combat zone. The extra day or two required for referral will result in more definitive surgery and a better chance of survival for the patient.

MAXILLOFACIAL INJURIES

GENERAL CONSIDERATIONS

Early debridement and primary closure of facial soft tissue injuries and reduction of facial fractures greatly alleviate postoperative complications, shorten the patient's convalescent time and reduce the number of secondary surgical procedures.

Aftere controlling hemorrhage and correcting airway embarrassment maxillofacial injuries are not life endangering and more serious casualties should take precedence. Early soft tissue treatment, however, is necessary but can be delayed with acceptable results.

MAXILLOFACIAL INJURIES

1. Airway embarrassment:

A. In injury to the mandible, the tongue and soft tissues lose their bony support and will frequently fall into the posterior pharynx if the patient is placed on his back.

B. If the patient is placed on his side or face down this problem is corrected and reduces the necessity of emergency tracheostomies in the field. Nascpharyngeal airways may be used at this time to maintain a patent airway.

C. Further evaluation of the patient is accomplished at a more sophisticated hospital to determine the necessity of a tracheostomy which frequently can be avoided.

D. With the patient placed in the lateral or prone position this also reduces the possibility of aspiration and swallowing blood.

2. Hemorrhage:

Hemorrhage may be significant due to the complex blood supply of the head and neck.

A. Hemorrhage should be controlled by ligation of the individual vessels, reduction and fixation of the fractures, nasal and maxillary sinus packing and by soft tissue closures.

B. There may be generalized ooze from traumatized muscle; adequate soft tissue closures with pressure dressings usually aid in controlling ooze type hemorrhage.

C. Elevation of head if there are no contraindications to a level of 30 to 40 degrees will minimize venous and capillary bleeding and also will significantly decrease swelling.

3. Antibiotics:

The treatment of grossly contaminated maxillofacial wounds requires high doses of one antibiotic keeping in mind that the oral flora is usually mixed with mainly gram positive organisms. High doses of Ampicillin or Penicillin alone have been effective.

4. Evacuation:

A. Patients should be given an anti-emetic by either the intramuscular or suppository route, Tigan, Torecan and Phenergan are useful agents.

B. All patients that are in intermaxillary fixation should have scissors with them at all times. These should preferably be maintained around their neck with umbilical tape. Scissors should be able to cut wires as well as elastics.

C. Patients should be instructed in procedures to cut the intermaxillary elastic and/or wires. They should be instructed to notify flight personnel immediately if they experience nausea or motion sickness.

D. Non-responsive patients or patients that are physically unable to cut wires should be watched closely by flight personnel.

E. Tracheostomy tubes with cannulae should be left in place. Rush tubes should not be used as tracheostomy tubes in evacuated patients.

CARE OF SPECIFIC AREA

1. Soft Tissue Wounds:

A. Wounds are prepped by thorough washing with antibacterial solutions (betadine/PhisoHex) and irrigated with copious amounts of sterile solution.

B. Maxillofacial wounds are debrided conservatively and closed primarily, in contrast to other war wounds where wider debridement is performed and wounds left open. (An exception is loss of large bony areas where closure will create a large dead space. These are best packed open.)

C. Small Penrose drains are desirable when involving the neck and angle of the mandible to prevent possible hematoma formation and fluid accumulation in dead spaces.

D. Large wounds are debrided and closed in the easiest manner possible realizing that reconstructive surgery will be required later.

E. Massive soft tissue defects of buccal areas are debrided and skin sutured to mucosa to maintain continuity of the injured areas.

F. Rotation or transposition flaps should be reserved for ideal conditions. Bare bone can be covered with moist dressings. Split thickness skin grafts may be used to aid in the closure of large, avulsed type soft tissue wounds.

G. Traumatically tattooed wounds are meticulously debrided with scrub brush or scalpel; often hundreds of small fragments of discolored material remain deep in the tissue. (Initial debridement is the optimum and often the last opportunity to remove these tattooing materials.)

H. In trauma of the external ear minimal debridement and skin closure will usually yield good results since tension is slight and blood supply excellent. All cartilage should be cleaned well and covered with skin to prevent chondritis. Partially avulsed portions of the ear if they have a pedicle should be reapproximated and sutured. Devitalized cartilage should be debrided. Intratemporal trauma to the facial nerve should be treated as soon as the neurological status permits. (If the tympanic membrane is intact the external canal can be packed for internal support)

I. Facial nerve lacerations should be reapproximated at the time of initial exploration. If the defect is too large to do a primary anastomosis then the nerve ends should be tagged with monofiliment suture through the epineurium for further identification, especially peripheral branches. Intratemporal trauma to the facial nerve should be treated as soon as the neurological status permits.

J. Injured submaxillary and sublingual glands should be removed. Injured parotid glands present a much more complicated problem and attempted removal of the injured gland at the time of injury is a time consuming exercise that is probably not justified. Good pressure dressing should be used to compress the dead spaces and possibly prevent a salivary fistula.

K. Lacerated parotid duct should be reapproximated if possible. This usually is very difficult and it may be more advantageous to place a polyethylene tube into the proximal duct and suture this to the mucosa of the oral cavity. This will promote epithelialization down the cannula into the oral cavity thereby creating a new orifice.

L. The status of the facial nerve should be noted in all head and neck trauma cases.

2. Mandible:

A. The usual war wound of the mandible is that of gross comminution and/or avulsion.

B. Treatment as to reduction would depend on many factors, however, the following steps are suggested in ALL CASES.

(1) Copious irrigation of the open wound.

(2) Removal of tooth fragments,foreign bodies and ONLY that bone that is flushed to the surface with the saline or loosened by the rinse.

(a) All bone that is attached to periosteum and/or soft tissue and that has a blood supply should be retained. This bone may act as a nidus of ossification in bone repair.

(b) Large segments of bone that may not be attached to soft tissue may be reduced with minimum transosseous wires to maintain the continuity of the mandible. Wires should be kept to a minimum since more periosteum is elevated to facilitate their placement with possible jeopardization of vital bone. Wires to stabilize many small fragments only add more foreign material and the possibility of infection. Transosseous wires are best avoided in contaminated areas.

(3) All bones should be covered by skin or mucosa.

(4) The wound should be closed in layers beginning with mucosa and ending with skin.

(5) When dealing with contaminated comminuted fractures of the mandible, the use of dependent through and through submandibular drainage is recommended.

C. Reduction of Mandible:

(1) In avulsion and/or comminuted mandibles more use of mandibular and palatal splints is advocated. After copious irrigation, debridement and closure, impressions should be made for the construction of splints. Splints may be placed as soon as manipulation of traumatized tissue allows without further breakdown.

(2) When full dentures or Gunning-type splints are used for fixation, they should be designed in such a manner that there is a large space in the anterior region to facilitate suction of secretions. The anterior teeth of the maxillary and mandibular dentures should be removed making suctioning of the oral cavity a simple task.

Mid-face Trauma:

A. Splints are invaluable in the reduction of platal and alveolar fractures. Utilization of maxillary splints are also necessary for through and through wounds of the palate where there is a loss of hard and soft structures. With the aid of the palatal splint the nasal cavity may be packed against the surface of the splint aiding in hemostasis and bony support.

B. Adequate fixation of mid-face fractures is frequently necessary to stem cerebrospinal fluid rhinorrhea.

C. Nose wounds are debrided, closed and packed to support nasal bones and to control hemorrhage.

D. Maxillary-zygomatic complex and sinus wounds are debrided through the wound or through a Calwell-Luc approach. A nasoantral pack may be placed for hemostasis and to support the orbital floor and rim.

E. Nasal and antral packs should be noted as to date put in, number of packs used and a conspicuous tail is most helpful. Antibiotic therapy should be instituted whenever a nasal or antral pack is utilized.

F. Frontal sinus wounds may include a craniotomy. If the anterior table is not repairable, then removal of all mucosa, plugging of the nasofrontal duct, and sinus obliteration should be done.

4. SOME FACTORS OF IMPORTANCE IN NECK WOUNDS

A. Significant vessel injury must be suspected even with small wounds. All wounds of the neck should be explored.

B. Various cranial nerves (IX,X, XI, XII) may be injured with missile wounds at the base of the skull but primary exploration and attempted repair is rarely indicated. The facial nerve is an exception.

C. Closed neck trauma with subcutaneous emphysema is presumptive of a ruptured viscera. Airway should be given priority followed by endoscopy and x-ray studies.

D. X-rays of the neck should be made to search for air in tissue planes. Air in tissue

planes, especially in the post-pharyngeal area, usually means perforation of air or food passages (although some air may be drawn into the planes when tracheostomy is performed or with the missile).

E. The signs and symptoms of laryngeal injury include:

(1) Swelling;

(2) Airway obstruction with stridor, retraction and cyanosis;

(3) Hoarse voice or aphonia;

(4) Drooling (adjacent esophageal swelling), pooling saliva;

(5) Crepitation in neck tissues;

(6) Visible or palpable injury to larynx.

F. Wounds of the air and food passages in the cervical region should be investigated first by esophagoscopy. They should then be surgically explored, a layered closure carried out, the wound drained and the skin closed primarily. Nasogastric tube feedings will be necessary in pharyngo-esophageal injuries until the wound is water tight (depending upon the size of the wound). Antibiotic coverage is mandatory.

F. Small wounds of the lower pharynx and cervical esophagus may be hard to identify upon exploration of the neck. Drains at the probable area of injury, nasogastric tube feeding, adequate antibiotic coverage will usually allow the wounds to heal without incident.

OPHTHALMIC INJURIES

Fragment wounds involving the globe, the eyelids, or the orbit are frequently seen. A large percentage of these wounds are associated with maxillofacial or neurosurgical wounds, and many cases will require the care of specialists in all three fields.

It is preferable for the ophthalmologist to be one of the first to perform surgery if a penetrated globe is felt to be repairable. Inadvertent pressure on the injured globe or dependent positioning on the operating table can result in prolapse of intraocular contents and the ultimate loss of the eye. Repair of a globe should be preceded only by surgery to correct a life-threatening situation.

1. INTRAOCULAR FOREIGN BODIES

If a penetration of the globe is present, and x-rays reveal a probable intraocular foreign body, a prompt attempt to remove the foreign body with the magnet is usually indicated. Precised radiographic localization is not possible in most hospitals in Vietnam, but an estimate of the location within the globe should be made by studying the AP, lateral and Waters views.

In most cases, an attempt should be made to remove the foreign body through the wound of entry. If a giant magnet is available, removal can be accomplished after the induction of anesthesia but before sterile preparation of the patient, care being exercised not to contact the globe with the unsterile magnet tip. Non-magnet sterile forceps are used to orient the eye in the desire position, and a non-magnet speculum must be used. The eye must be oriented so that the wound of entry and the estimated position of the foreign body are in line with the main line of magnetic force before the magnet is activated.

In many cases, the preliminary unsterile attempt at removal will be unsuccessful, in spite of the fact that movement of intraocular structures have indicated that the foreign body is magnetic. Sometimes the foreign body is trapped at the wound of entry by conjunctiva or prolapsed uveal tissue. In such a case, the patient should be properly prepared for sterile surgery, and the wound should be exposed and prolapsed tissue excised to free the way for the extraction of the foreign body. The magnet is then re-introduced, with a sterile tip to accomplish the removal. The less powerful hand magnet may require direct contact with the globe or even entry into the wound to accomplish removal.

If it is judged to be unwise to attempt removal through the wound of entry, an incision can be made through the pars plana for extraction. It is probably best, however, not to perform this type of surgery without the benefit of more precised localization techniques, and attempts at extraction should probably be delayed until after evacuation, where such techniques are available.

No attempt should be made to extract a non-magnetic foreign body.

Efforts to extract foreign bodies which are intraorbital but extraocular are usually ill-advised. If a foreign body is very large and located in the anterior orbit, removal may be attempted, but attempts to remove foreign bodies from the posterior orbit are very hazardous, and usually the damage caused by the surgery exceeds the damage caused by the retention of the foreign body.

2. CORNEAL LACERATIONS

Perforating wounds of the cornea are common. Often repair is difficult because of the stellate shape of the laceration. Prolapsed iris should be excised and the wound completely cleared of iris tissue. Repair should then be made with 7-0 or 8-0 silk. The use of fine-toothed forceps (Colibri type or Bonn) is essential for an accurate closure.

Air should be injected into the anterior chamber at the conclusion of the repair, both to test the tightness of the closure and to assure that anterior synechiae will not form. It is often very difficult to inject air through the laceration itself, and a counter-puncture with a knife-needle (Swan or Ziegler) is often necessary, and in many cases will facilitate the retention of an air bubble which could not be achieved by injecting through the laceration. In some cases, where the wound is old and the cornea very soft or where there is a very jagged, stellate laceration, it is impossible to achieve an air-tight closure. Fortunately, most of these cases will spontaneously form an anterior chamber during the first several postoperative

days.

3. SCLERAL LACERATIONS

The apparent size of a scleral laceration is often deceptive and thorough exposure often reveals the laceration to be huge and irrepairable. If the intraocular contents are not prolapsed, however, repair of even large lacerations should be attempted. Prolapsed uveal tissue and vitreous should be excised. 6-0 chromic catgut has proven to be an excellent suture for repair. The conjunctiva is then closed with the same material.

Many eyes with scleral lacerations and vitreous hemorrhage are found to have no light perception on initial examination, despite the fact that the damage does not appear to be devastating. The frequency with which this occurs is very discouraging, but surprisingly, a significant percentage of these eyes will regain light perception and even some formed vision. Certainly repair should be attempted if possible, in spite of initial lack of light perception.

A reliable sign of a relatively posteriorly located scleral laceration or rupture is recession of the iris and ross deepening of the anterior chamber. Such eyes should usually be explored, although many of the lacerations will be located too far posterior to be repaired.

4. INFECTIONS

The incidence of endophthalmitis has been high in Vietnam, and the usual offending organisms are gram negative rods. Penetrating injuries from mines, which give a "mud-blast" effect are extremely likely to become infected, despite prophylactic antibiotics.

Prophylactic antibiotics are indicated in every penetrating injury of the globe, and an antibiotic must be chosen which will penetrate the non-inflamed eye. In Vietnam, it is essential to choose an antibiotic with a wide gram negative spectrum, and it is also advisable to choose an anti-Pseudomonas agent. Many antibiotics are effective and safe when given by the sub-conjunctival route. Chloramphenicol (50 mg.) and Colistin (20 mg.) provide a wide spectrum of coverage. These two may be combined with Penicillin G (500,000 units) or Ampicillin (50 mg.) for more complete gram positive range. The best choices systemically are Chloramphenicol (500 mg. q6h p.o. or IV push), Ampicillin (500-1000 mg. q6h p.o., IM, or IV), or Cephaloridine (1 g. q6h IM or IV).

The treatment of endophthalmitis is subject to many variations. The Handbook of Ocular Therapeutics and Pharmacology by Ellis and Smith is particularly helpful. One acceptable regimen for initial therapy consistes of IV Chloramphenicol and Ampicillin, intensive topical application of Neosporing with added Polymixin B, and daily sub-conjunctival injections of Chloramphenicol, and Colistin. In general, however, the therapeutic results from any regimen are very disappointing.

5. EYELID LACERATIONS

Even with extensive, irregular lacerations, accurate anatomic closure is usually possible. Every effort should be directed toward achieving a precise approximation in order to avoid the need for subsequent plastic revisions. If there has been avulsion of the large portions of the lids, accurate closure is, of course, impossible, but an attempt must be made to achieve as complete a closure as possible. If the lid margin is absent, skin should be closed to conjunctiva.

Debridement should be minimal. All foreign material should be carefully removed, but very littel skin should be removed. Even skin which appears to be non-viable should be preserved in most cases; such tissue has survived in a high percentage of cases. In general, the use of rotation or sliding flaps is contraindicated as a primary procedure because infection then endangers this otherwise normal tissue. Early split thickness grafts taken from a remote site are preferrable; flaps may be mobilized at a later date.

Closure of lid lacerations should be made in two layers, 4-0 catgut is recommended for the conjunctiva-tarsal plate layer, and if interrupted sutures are used, inversion of the stitch is recommended in order to bury the knot, particularly if the globe has not been removed 6-0 silk is recommended for the skin. Larger lacerations, not involving the lid margins may be closed with 5-0 nylon, which produces less tissue reaction. Nylon sutures,however, are much more prone to scratch the cornea and should not be used near the globe.

Soft tissue infections are not uncommon, and are particularly likely following "mud-blast" injuries. The infected wounds should be covered with wet fine-mesh gauze, covered by dry gauze and Kerlix wrap. These dressings should be changed three or four times daily. The frequent changing of the wet gauze provides effective continuous debridement. Usually, early suture removal is necessary to allow adequate drainage. Hydrogen peroxide cleansing is also helpful. Antibiotics must be started immediately.

6. ENUCLEATION AND EVISCERATION

The choice between these two operations is largely dictated by the surgeon's own preference, although many globes are too shattered to be amenable to evisceration.

The ideal enucleation procedure involves the isolation of the rectus muscles and the attachment of the muscles to some type of implant. This,however, is a time-consuming procedure, and the long-term advantages are not striking. Time often dictates against choosing this longer procedure in a war zone, and the results from simple insertion of a plastic sphere have been satisfactory. Some additional mobility and security for the implant can possibly be gained by simply joining the four rectus muscles anterior to the sphere without actually attaching them to the implant.

It is desirable to replace as much volume as possible in most cases, and an 18 mm. implant can usually be used. There has been some difficulty with extrusion of these larger implants,however, and if there is any doubt, a 15 mm. implant should be chosen. The insertion and maintenance of a lid conformer is important, although destruction of lid tissue and conjunctiva sometimes makes the insertion of a conformer impossible.

If evisceration is performed and the cornea is left in place, it is important not to choose too large an implant. Pressure necrosis of the cornea can result.

7. ORBITAL FRACTURES

Blow-out fractures of the orbital floor often present first to the ophthalmologist. Initial peri-orbital swelling often makes the diagnosis difficult, but surgery may safely be postponed up to 10 days after injury, and in fact it is usually desirable to postpone surgery until the acute swelling has at least partially subsided.

Waters views often are helpful in making the diagnosis, but a negative x-ray does not rule out the presence of a significant fracture. It is very uncommon for a floor fracture to exist in the absence of infraorbital hypesthesia, although the presence of hypesthesia is certainly not diagnostic of such a fracture. Vertical diplopia is highly suggestive sign, and inability to elevate the eye makes the diagnosis very likely. It is also possible to have difficulty in depressing the eye. It is important in evaluating the diplopia to determine whether the objects are separated vertically rather than horizontally; horizontal diplopia is of no significance in the diagnosis of a floor fracture. The forced duction test is very valuable in demonstrating inferior rectus trapping and can be performed under local anesthesia.

Surgical repair can be accomplished by either the orbital approach or a combination of the orbital approach and Caldwell-Luc. The Caldwell-Luc procedure alone is probably an inferior method of repair because there is no assurance that trapped muscles have been freed fr om the fracture. A wide variety of implant materials have been employed, but Silastic or Supramid sheeting is generally available and, in general, either has proven to be satisfactory.

8. HYPHEMA

Traumatic hyphema following blunt injury is extremely common. The preferred treatment is five days of absolute bed rest and binocular patching. Neither mydriatics nor miotics should be used. Mild sedation is desirable.

Glaucoma following secondary hemorrhage should be treated conservatively if possible, with Diamox, elevation of the head of the bed, and Glycerol or Mannitol as needed. If the intraocular pressure persists at dangerous levels, surgery must be performed. Paracentesis may be performed initially, but results are often disappointingly short-lived. A corneo-scleral section with removal of the clot by irrigation is much more likely to produce a lasting cure.

9. CORNEAL FOREIGN BODIES

Most corneal foreign bodies can be removed without difficulty. Extremely deep

foreign bodies which are likely to produce loss of the anterior chamber on attempted removal, however, should probably be evacuated to a facility where removal can be performed in the operating room with the aid of an operating microscope.

10 PROPTOSIS

Proptosis secondary to retrobulbar hemorrhage ordinarily requires no treatment. Rarely, however, the proptosis is so severe that lid closure is impossible, and there is corneal exposure. Lid closure must be achieved for corneal protection. If the lids cannot be held closed with a pressure patch, temporary suturing of the lids together or even an intermarginal tarsorrhaphy may be necessary. In extreme cases, it may be necessary to incise the orbital septum to allow evacuation of the clot.

NON-SPECIALIZED MANAGEMENT OF OPHTHALMIC INJURIES

1. INITIAL EXAMINATION

The basic problem in the evaluation of a casualty is to determine the gravity of the ocular injury. Eyes will fall into one of four groups:

1. Normal

2. Injury, minor, not requiring evacuation to specialist.

3. Injury, major but repairable, requiring evacuation to a specialist as promptly as possible.

4. Injury major and not repairable, requiring evacuation but not as urgently as group 3.

Usually the most difficulty is encountered in separating group 3 from group 4, and indeed this is often difficult for an ophthalmologist.

The basic question is whether the eye is useful. Any eye which perceives light is certainly useful, and every effort must be directed toward saving it. Even a totally blind eye is useful if it is a relatively normal appearing eye because such an eye is usually cosmetically much more acceptable than a prosthesis.

A. Visual Acuity.

If the patient is unable to voluntarily open his eyelids, they should be opened with gently pressure by the examiner. Great care must be exercised to apply pressure only on the orbital rims, and not on the globe itself. Direct pressure on the globe itself can result in further prolapse of intraocular contents through a corneal or scleral laceration.

The opposite eye is covered firmly with the examiner's hand, and the patient is asked if he can see a bright light, held very close to the eye. If there is doubt, the patient should be quizzed as to whether the light is on or off. If light perception is present, he is asked if he can detect the movement of a hand a few inches before his eye, and then to count fingers held about a foot away.

B. Basic Condition of Globe.

Initial inspection may reveal an obvious corneal or scleral laceration or a complete collapse of the globe with loss of intraocular contents. There may be obvious signs such as a hypema, an irregular pupil, or foreign bodies. The globe may be palpated very gently through the eyelids to determine the basic firmness. Whether a globe has maintained its basic shape and firmness is usually a much better prognostic sign than is the apparent size of a laceration or the presence of a hyphema.

A corneal laceration is usually signalled by distortion of the pupil with prolapse of iris tissue through the laceration. A scleral laceration often has the same finding, and will always appear jet black, due to the presence of heavily pigmented uveal tissue lying immediately beneth the sclera. With large lacerations there may be extensive prolapse

of intraocular contents and collapse of the globe, making repair impossible. Whether or not a globe has maintained its basic shape and firmness is a much better prognostic sign than is the apparent size of the laceration.

2. INTERIM MANAGEMENT

Corneal and scleral lacerations which are judged to be repairable should be taken to surgery as soon as possible, but if the patient's life is in serious jeopardy because of other injuries, a delay of 72 hours is acceptable. After the initial ocular examination, a sterile patch should be kept on the eye, and systemic antibiotics must be started. Topical drops or ointments should be avoided and no interim surgery should be attempted.

If an eye is judged to be hopelessly destroyed,a longer delay can be tolerated, although prompt surgery is still desirable. If the eye is kept covered and the patient is maintained on prophylactic antibiotics, a delay up to 7-10 days is acceptable.

3. SYMPATHETIC OPHTHALMIA

Sympathetic ophthalmia is a chronic, severe inflammation induced in the normal fellow eye, following penetrating injury to the globe and appearing 2 weeks or more following injury. It is thought to be produced by an auto-sensitivity to uveal pigment, released by injury to the uveal tract. Although it is a very rare disease, it is devastating. It can be prevented by removing the injured eye during the first 10 days after injury, and in the vast majority of cases the safety period is even longer. The threat of sympathetic ophthalmia does not alter the approach to the treatment of ocular injuries if the eye has salvage potential, but if an eye is destroyed, early removal is mandatory. A destroyed eye, in this sense, must be considered a dangerous eye, and removal should not be delayed past the first 10 days.

4. FOREIGN BODIES

The presence of an intraorbital or intraocular foreign body on x-ray does not alter the interim management, and it also does not alter the urgency for evacuation. No attempt should be made to remove either an intraorbital or intraocular foreign body prior to evacuation to an ophthalmologist.

5. ANTIBIOTICS

Infections have been a formidable problem in Vietnam, and many eyes have been lost because of intraocular infection. Prophylactic antibiotics are essential in the treatment of a penetrating ocular injury, and even with the use of prophylactic antibiotics, infections have continued to occur. As has been the case in general surgery, gram negative rods have been the principal offenders.

The choice of antibiotics for ocular prophylaxis is complicated by the fact that many commonly used antibiotics do not penetrate the non-inflamed eye in any significant concentration. Penicillin and Streptomycin, for example, are poor choices because of their poor ocular penetration. The best drugs and their dosage are as follows:

Chloramphenicol	500 mg. q6h p.o. or IV push
Ampicillin	500-1000 mg. q6h p.o., IM, or IV
Cephaloridine	1 g. q6h IM or IV

6. LACERATIONS OF THE EYELIDS

Lacerations of the eyelids are basically handled in the same manner as are lacerations of the face. For proper function,however, correct anatomic approximation is essential, and for this reason repair by an ophthalmologist is desirable, particularly if the laceration involves the lid margin. Lacerations involving the lacrimal canaliculi require special techniques for repair.

A delay of up to 72 hours is acceptable in the repair of lid lacerations, although the risk of infection is greatly increased, and prophylactic antibiotics are indicated. If repair must be performed prior to evacuation, debridement should be minimal, and every effort should be made to properly approximate the lid margin. Closure should be made in two layers,

using catgut sutures to close the conjunctiva-tarsal plate and fine silk to close the skin. If the cornea is exposed because of tissue loss, use 4-0 silk to approximate any tissues available for temporary cover. Copious antibiotic ophthalmic ointment should be applied frequently to cover any exposed area. Prolonged exposure is dangerous, and prompt evacuation is indicated.

7. MINOR INJURIES

Certain minor eye injuries can often be handled without the aid of a specialist.

A. Corneal Abrasions

The patient should be treated with a drop of homatropine (2% or 5%) or scopolamine 1/4% initially, Neosporin drops or ointment and a patch. The patch may be discontinued when the patient is comfortable.

Continued use of topical anesthetics to make the patient comfortable is contraindicated. These agents are toxic to the corneal epithelium and significantly delay healing.

B. Corneal Foreign Bodies

Corneal foreign bodies can usually be removed easily after the instillation of a topical anesthetic. Removal should first be attempted with a cotton applicator. If this is unsuccessful, a hypodermic needle should be used to flick out a particle which is superficially embedded. If the foreign body proves to be deep or difficult to remove, the patient should be evacuated to an ophthalmologist.

Following removal of a foreign body the treatment is the same as for a corneal abrasion.

C. Thermal Burns

Thermal burns are treated in the same manner as corneal abrasions. A topical steroid-antibiotic solution or ointment, such as Neo-decadronor Cortisporin may be used.

D. Chemical Burns

Chemical burns of the cornea and conjunctiva are treated with immediate irrigation with normal saline or water (preceded by the instillation of a topical anesthetic), and removal of any particulate matter such as chemical particles. Otherwise the treatment is the same as for a corneal abrasion.

Caustic burns (lye,quick-lime) are potentially very destructive and should be evacuated promptly, particularly if there is corneal clouding. Copious irrigation for at least 30 minutes must be performed prior to evacuation, however.

E. Subconjunctival Hemorrhage

Subconjunctival hemorrhage is often frightening in appearance but is rarely of any consequence. It can occur spontaneously or as a result of minor trauma. In casualties it is most often seen as a manifestation of retrobulbar hemorrhage and is often associated with a periorbital hemorrhage. No treatment is necessary.

F. Hyphema

Hyphemas are potentially dangerous, and most should be treated by an ophthalmologist if evacuation is feasible. If evacuation is not possible, treatment should consist of absolute bed rest and bilateral eye patches for five days. It is necessary to continue for five days, even if the hyphema is resolved in order to minimize the risk of a secondary hemorrhage which often is massive. Should a secondary hemorrhage occur, the increased amount of blood in the anterior chamber will be apparent, and the bleeding is usually accompanied by a sudden increase in pain. If the secondary hemorrhage does not completely fill the anterior chamber, do not alter the therapy. If the hemorrhage does fill the anterior chamber, and the pain continues, prompt care by an ophthalmologist is mandatory because of the likelihood that severe secondary glaucoma is present.

G. Irregular Pupil

Damage to the sphincter muscle of the iris is common following trauma to the eye. The usual manifestation is slight irregularity of the pupil and some dilatation. Light response is poor, but vision is unaffected. No treatment is necessary, although the condition is often permanent.

H. Traumatic Iritis

Traumatic iritis is very common following trauma and often accompanies damage to the sphincter muscle. The symptoms are mild photophobia and redness. The iritis is self-limited and requires no treatment, although topical steroids can be used.

ANTIBIOTICS AND SEPSIS

Infections have been a frequent sequel of wounds throughout the history of military medicine. Adequate debridement, immunization and antibiotics have significantly reduced the incidence of wound complications such as gas gangrene, tetanus and streptococcal cellulitis. However, massive infection in wounds created by weapons of both modern (e.g., high velocity missiles) and primitive (e.g., punji sticks) warfare remains a major problem at all levels of medical care in-country, offshore and in CONUS facilities.

The following facts are extremely important in the evaluation of proper antibiotic therapy:

1. Antibiotics, regardless of the type, number and combination utilized, are no substitute for adequate debridement, fecal diversion where indicated and proper drainage.

2. Abscesses, in general, require drainage as the primary therapeutic modality. Antibiotics play an important but secondary role in therapy.

3. Certain injuries carry significantly increased risk of subsequent sepsis and such infection once established creates a critical life-threatening situation. Examples of such "high risk injuries" are:

a. Colon and spinal cord disruption by a single missile.

b. Right colon injuries associated with hepatic and/or small intestinal damage.

c. Transverse or left colon injuries associated with splenic and/or gastric damage.

d. Colon or small bowel injuries associated with wounds of the bony pelvis.

e. Vascular injuries associated with large soft tissue destruction.

f. Booby trap or mine injuries of the buttocks, perineum and thighs often associated with lower extremity amputation, urinary tract and rectal injury.

g. Major burns.

4. The actual incidence of significant wound infection is high, particularly so in injuries involving more than one organ system. PACOM facilities are treating most of the significant septic problems and at that level of care sepsis is by far the greatest cause of death; such sepsis being usually due to a gram negative invasive infection. Statistics such as 15 percent incidence of significant abdominal wound infections, seven percent incidence of subphrenic abscess in all intra-abdominal fragment wounds, give some evidence of the magnitude of the problem of sepsis and its control in the management of war wounds.

5. Antibiotics, to be effective, should be as specific as possible to eradicate the particular sensitive invasive organism. The appropriate antibiotic therapy should be begun as soon as possible after wound contamination. Culture techniques and sensitivity studies are the only means to determine the proper antibiotic for the offending organism.

6. The use of antibiotic treatment in contaminated wounds (in contradistinction to wound infection) is not considered "prophylactic", but rather therapeutic, particularly in war wounds. This means beginning the antibiotic as soon as possible after injury, usually intravenously.

7. The primary problem in the use of antibiotics is the time required to get culture and sensitivity studies. Contaminated wounds, untreated with antibiotics during this "lag time" become infected wounds and if the wounds are "highly infection prone", disaster quickly ensues in the form of sepsis. Numerous antibiotic regimens have been proposed to decrease the incidence of sepsis during this "lag time". Once cultures are confirmed and sensitivity studies performed the specific antibiotics needed for control of sepsis are evident.

8. No single regimen, plan or program of "lag time" antibiotic coverage has proven effective at all levels of care. Numerous reports were received at this conference which confirmed the increasing septic problems with gram negative organisms, their resistance to Penicillin and Streptomycin therapy and their severe morbidity and mortality.

9. Cultures of wound surfaces have some relation to the type of wound infection, but such a

relationship may be indirect and misleading. With proper culture techniques, all open wounds will be found to harbor organisms; whether or not invasive wound infection is present is another question. The use of Penicillin results in suppression of gram positive organisms on the wound surface, and with time gram negative organisms can be cultured from these wounds. The use of Streptomycin seems to enhance the more rapid appearance of gram negative organisms in the wounds and the great majority of these organisms will be resistant to this antibiotic.

10. Sepsis may mask malaria, as well as malaria masks sepsis. Numerous patients are being seen with both bacterial infection and malaria. Both appropriate antibiotic and antimalarial therapy must be utilized to control such sepsis.

11. If antibiotics are to be used effectively they must be used in adequate dosage and for adequate times. All too frequently the course of antibiotic therapy has been illogically conceived, erratic, inadequate, both in duration and dose and even prolonged far in excess of therapeutic need. Such use not only does not help the patient but, even worse, encourages the development of resistant organisms.

12. A note of caution is expressed in the use of topical antibiotics or continuous irrigation with antibiotics (i.e., Neomycin and other ototoxic agents) that result in subsequent deafness.

13. Chloramphenicol continues to be a life-saving drug.

On the basis of the above facts the following recommendations are made:

1. Culture and sensitivity reports in patients with contaminated wounds and otherwise doing well are not in themselves indication for switching antibiotics.

2. High dose Penicillin therapy (e.g., 20 to 40 million units IV per day) has proven effective in controlling the gram positive infections and some gram negative ones. Pencillin is recommended in seriously injured patients who are not allergic to it.

3. Proper gram negative "lag time" antibiotic coverage must be determined by each local hospital staff using as guidelines their individual experience based on previous culture populations.

4. Streptomycin is NOT felt to be a suitable antibiotic for use during this "lag time". Its use as a "prophylactic" antibiotic is both ineffective and hazardous.

5. Careful and concise antibiotic orders must be written, including dosage, route of administration, time of therapy and duration. Culture reports frequently are missing at the time of chart transfer to other medical facilities. Flight tags must accurately reflect antibiotic therapy during the process of evacuation. (This likewise applies to antimalarial treatment)

6. The problems of sepsis and the proper use of antibiotics are not solved satisfactorily at present. Intensive research must be conducted in these areas. Wound swab studies are not sufficient and may be misleading. The role of topical antibiotics, bacteriostatics and germicidals in war surgery needs further and continuing study. Constant and diligent research is necessary to intelligently provide the "best antibiotic treatment during the lag time".

7. A high degree of suspicion is necessary for the early diagnosis of suprainfection (fungal and other opportunistic organisms).

TOPICS SUGGESTED FOR FURTHER STUDY

1. Resuscitation of the wounded on the battlefield prior to transportation to a definitive treatment facility, including pitfalls.

2. Methods, principles and practices in Vietnam.

3. Study of ground level blast injuries with special attention to initial debridement and prevention and/or management of life threatening infection.

4. Continued study of peritoneal lavage with antibiotic solutions as a treatment of peritonitis.

5. Use of marlex, silastic or other synthetic materials for coverage of large abdominal wall defects.

6. Professional aspects of helicopter evacuation of the wounded.

7. Professional aspects of the in-country evacuation of the wounded.

8. Professional aspects of out-of-country evacuation of the wounded.

9. Methods and means of getting early feedbacks of patient follow-up data to the initial surgical team.

10. Means of publishing the results of the War Surgery Conference in a major Surgical Journal.

SPECIAL PRESENTATIONS

The following are authors abstracts of presentations given before the conference attendees.

I. Problems and Pitfalls in Strategic Aeromedical Evacuation of the Wounded.

Roger C. Breslau, LTCOL, USAF,SURGERY,USAF HOSPITAL TACHIKAWA

I. General Points

A. Medication

1. Generous ordering of analgesic medications during the period of travel,often of a higher grade than those needed at the referring station, are recommended in route.

2. Pure pain relievers rather than caffeine-containing compounds are strongly recommended.

3. Oral Medications are preferable to parenteral if feasible.

B. Dehydration

0 to 10% cabin humidity must be compensated for by specific orders for augmented oral or parenteral administration of fluids during movement.

C. Fatigue

A progressive deterioration of a patient's condition may be anticipated during prolonged evacuations. The patients frequently arrive at destinations in exhausted and demoralized condition despite supportive care enroute. The ability of a recently wounded or operated patient to stand the rigors of from 44 to 124 hours of time enroute from a definitive care hospital in-country to a definitive care hospital in CONUS must be carefully considered before manifesting such patient for CONUS destinations.

II. Specific Points

A. Trapped Gas Problems

1. Intestinal trapped gas is the most common problem encountered following high altitude flights. All enterostomy tubes should be left in place and must be left unclamped during the entire movement process to forestall this problem.

2. Trapped air in other closed body spaces such as the pleural space or cranial cavity are relative contraindications to early movement by air unless other overriding medical considerations are present.

B. Vascular Problems

1. The greatest majority numerically of "blow-outs" of arterial repairs occurs before the 21st postoperative day. A general policy has been established that patient will not be moved on long over-water flights prior to the 21st post repair day.

C. Cast Problems.

1. Indications for bivalving casts are adequately discussed in the specialty section on Orthopedics.

2. All patients with recent vascular repairs must have a generous window in the cast over the repair site.

3. The maximum diameter of the exit ports in the C-141 aircraft is 22 inches, and this factor should be considered in constructing spicas which exceed this diameter.

D. Anemia

1. Patients with hematocrits in the range of 30% or less do not tolerate prolonged aeromedical evacuation well, and suffer fatigue out of proportion to their general status. Hemoglobin in the range of 35% HCT is recommended.

E. Wire Suture Closures-Multiple - Wound closures with stainless steel wire which involve all body surfaces provide an intolerable environment for patients who are unable to change their position during prolonged evacuation. Consideration should be given to early suture removal and replacement with microporous tape support on at least one body surface to permit confortable rest enroute.

F. Drug Habituation- Many patients fail to confess their dependency upon a variety of addictive agents until the evacuation process is well enroute. Unless adequate sedation or specific maintenance medication for habituees is provided for the period of travel, the least problem is the removal of the patient from the evacuation system for appropriate treatment at an enroute station and the greatest hazard is that of an assaultive and delusional patient in the confined space of an aircraft, presenting a great hazard to other patients and flight crew personnel.

II. Recurrent Pitfalls in the Management of Neurosurgical Combat Injuries

Robert C. Meredith, CDR/USN,MC, NEUROSURGERY, USNH FPO SEATTLE 98765

The recurrent problems in the neurosurgical treatment of combat injuries are almost entirely related to incomplete, or inadequate, observation and incomplete treatment based on these observations. More thorough preoperative and postoperative patient evaluation by appropriate examination and x-ray and more complete and thorough debridement based on the findings would result in correction of the problem. Representative examples are given. Wider dissemination of the recommendations of the previous conferences and combat surgery experience and a better adherence to the therapeutic principal recommended would seem to be the answer. Specific recommendations for correction are as follows:

1. The first specialist sent to the combat area should be the senior, more experienced neurosurgeon, preferably with prior combat experience.

2. Less than fully trained men should not be sent to a combat situation.

3. Overlap all rotation assignments.

4. All medical officers reporting to the combat zone should be supplied with copies of war surgery conferences and recommendations for treatment.

III. Management of Combat Wounds of the Dural Venous Sinuses

John Kapp,MAJ,MC,USA
Issac Gielchinsky,MAJ,MC,USA
Carl Mead, MAJ,MC,USA (Presented Paper) Neurosurgery 24TH EVAC Hospital, Long Binh

Surgical management of dural sinus injuries has always been difficult due to massive blood loss, venous obstruction or air embolism. A shunting device composed of a noncollapsible, siliconized tube with inflatable cuffs on each end has been developed to bypass areas of laceration. This has enabled better visualization of the injured area without compromise of the venous flow. Saphenous vein grafts have been utilized to reconstruct major injuries which can not be repaired by primary suturing. It was felt that this material because of its endothelialized surface was less likely to precipitate thrombosis than previously used grafting material.

IV. Penetration Wound of the Neck .

Vernon H. Fitchett, CAPT,USN, DEPT SURGERY, USNH OAKLAND,CALIFORNIA

A high index of suspicion on all neck wounds must be maintained. All neck wounds should have formal exploration under general anesthesia except those wounds posterior to the sternocleidomastoid muscle which have been proven by x-ray and clinical examination to be

superficial. 52% of all neck injuries studied from Vietnam had injury to a vital structure. Every neck exploration, regardless of how inconsequential the external lesion may seem, should be draped wide for the possibility of a sternal split. Esophageal lacerations may be obscure and should be searched for diligently. Only by strict adherence to proven principles of surgical management can we hope to improve on the mortality rate of patients sustaining penetrating wounds of the neck.

V. Management of Massive Abdominal Wall Injuries.

W. Wilson, MAJ,USA, GEN SURGERY, USA HOSPITAL CAMP ZAMA, JAPAN

NO ABSTRACT SUBMITTED.

VI. PHYCOMYCOSIS AS SEEN IN VIETNAM WAR CASUALTIES IN ARMY HOSPITALS IN JAPAN

William L. Buhrow, MAJ, MC,CHIEF, GENERAL SURGERY SERVICE, USAH CAMP ZAMA,JAPAN

A review of 17 cases of invasive phycomycosis (mucormycosis) from the 106th General Hospital, the 249th General Hospital and U.S. Army Hospital Camp Zama for the period 1969-1971 is presented. The case collection is felt to be incomplete but representative of various features of the disease. Nine cases resulted from multiple fragment wounds, 1 from blunt trauma and 7 from burns. Nine cases ultimately were air evacuated to CONUS, apparently free of the disease, 7 cases died and 1 remains hospitalized in Japan with a doubtful prognosis. Susceptible individuals, various presentations of the disease and typical courses are described. Recommendations include pleas for early diagnosis of the typical lesions with frozen section biopsy, wide local resection of the lesion with a margin of healthy tissue, margin checks for uninvolvement with frozen section , redical amputations (including hip disarticulation and forequarter amputation) when major neurovascular involvement occurs, systemic amphotericin B when the threat of the disseminated form is present,careful follow-up observation of the wound and correction where possible of underlying predisposing conditions.

VII. WOUNDS OF THE RECTUM

John A. Lung, LTCOL,MC,USA(PRESENTED PAPER) SURGERY USAH CAMP ZAMA
Robert P. Turk.LTCOL,MC,USAF
Robert E. Miller,COL,MC,USA
B. Eiseman,M.D.

From January 1968 through January 1971, twentynine patients with combat incurred penetrating wounds of the rectum were encountered at Fitzsimons Army General Hospital. Two-thirds of the patients in this series had associated injuries to other organs. Complications were frequent and occured in 72% of the cases. Septic problems were encountered in 50% of the series. Hemorrhage, intestinal obstruction and fistula formation occurred in several cases.

Etiologic mechanisms responsible for most complications could be traced to three factors:

(1) Inadequate drainage, 30% of the cases;

(2) Retained foreign body, 24% of the cases; and

(3) Non-diverting colostomy, 24% of the cases.

Herewith the total care of these unique wounds is summarized :

(1) Thorough evaluation of all patients with sounds of the pelvis is mandatory; this entails proctosigmoidoscopy.

(2) Hemostasis may require a gluteal flap for exposure. Rarely is it necessary to pack the wound to achieve hemostasis.

(3) Meticulous debridement with removal of all foreign material is imperative.

(4) A totally diversional colostomy must be performed and the distal colonic segment cleansed.

(5) Closure of the rectal wound and reapproximation of the sphincter muscle should be attempted.

(6) Adequate posterior drainage must be established and usually requires coccygectomy.

(7) Persistent purulent drainage requires early re-evaluation and exploration.

VIII. RESULTS OF A CASUALTY EVACUATION FEEDBACK CARD SURVEY

Spencer Walton,COL/USA, CHIEF OF ORTHOPEDIC SERVICE,US TRIPLER GENERAL HOSPITAL

The general condition of casualities arriving at CONUS hospitals is satisfactory in eighty-eight and one-half per cent of the cases. The condition of the wounds, fractures and amputations specifically is much less than totally satisfactory. There has been an inordinately high infection rate. Approximately two out of three fracture cases have the fractures satisfactorily aligned. Fifty-two per cent arrived without callous union and therefore could be satisfactorily re-aligned at the CONUS facility. Approximately ninety per cent of the patients were deemed adequately immobilized during evacuation. Ninety per cent were rated as having excellent to good care during the treatment prior to arrival at the CONUS hospitals. Fifty-seven per cent of the patients are estimated to require future medical separation from the Service with forty-three per cent being returned to duty of some sort. During the course of a tour of all Army hospitals in Vietnam during the first two weeks in April 1970, approximately 2,000 orthopedic wounded casualties were seen in these medical facilities and in some of the allied facilities visited. There was noted to be considerable variation of standard techniques encountered. It is felt that this deviation from standard techniques is probably the single most important cause of the high infection rate, along with the inexperience of the surgeons who are performing major orthopedic work.

IX. URETERO-COLIC FISTULA-AN UNUSUAL COMPLICATION OF RVN WOUNDS

John Weigel, CO,MC,USA, Urology,CAMP ZAMA

Of twenty-one patients with ureteral injuries sustained in RVN and later transferred to Camp Zama Hospital, two patients have had the rare complication of uretero-colic fistual. These cases were discussed along with a brief review presented on slides of various aspects of ureteral trauma-cause, types, and causes of complication. Specific modes of treatment were not within the scope of the paper.

Both patients with fistula were treated with ureteral catheterization- a conservative approach- and both healed without further complication.

X. UNEXPECTED FINDINGS IN ORTHOPEDIC PATIENTS FROM SOUTEAST ASIA

H. G. Williamson,LTCOL,USA, ORTHOPEDIC SERVICE, CAMP ZAMA,JAPAN

To summarize, debridement criteria established by the military physicians who have preceded us is still valid. The physician who ignores these principles and seeks to improve the basic principles usually fails. The patient suffers. We continue to see the error of excision of excessive skin and not enough muscle. Debridements are done with incisions placed in haphazard directions. Multiple incisions are seldom converted to linear incisions which would expose the underlying muscle groups. Fasciotomies should decompress underlying muscles, especially in the high adductor region, the anterior compartment of the leg and the plantar aspect of the foot. Amputations should be of the open circular type without preformed flaps. Skin treaction should be applied to the skin and not by skin sutures. Stint dressings should not be used. Most hand wounds can be and should be treated open. Closed fractures should not be opened in Vietnam and tendons should not be repaired. Expect that a good percentage of muscular debridements will have to be redebrided. Explore all joints that have had penetrating injuries, especially those with retained foreign bodies. Joints can be left open if the injury

has caused gross contamination or if there is loss of capsule and synovium. Immobilize the hand in a position of function, stabilize metacarpal fractures with transverse K-wires. Dislocations can be stabilized by the same method to protect neurovascular bundles and joints. Expect that the patient has lost considerable blood when there are open fractures and the hematocrit during the first 72 hours will not necessarily be accurate. Transfer the patient to the next echelon of treatment only when his medical condition permits; do not be pressured to move the patient except for his own welfare. Finally, do not anticipate that a patient who has shown improvement during the past two days will continue to improve enroute to Japan or the US. It has been our experience in Japan that without exception there is no further improvement enroute and most patients will under go deterioration.

XI POST-TRAUMATIC ACUTE ACALCULOUS CHOLECYSTITIS IN EVACUEES FROM THE VIETNAM CONFLICT

Martin L. Fackler, CDR,MC,USN, GENERAL SURGERY, YOKOSUKA,JAPAN
Charles L. Brodhead, CDR,MC,USN,SURGERY, YOKOSUKA,JAPAN

In 1969 at Yokosuka Naval Hospital four cases of acute post-traumatic acalculous cholecystitis were seen.

Multiple system injuries were present in all cases.

The cholecystitis was the primary reason for surgery in two of the cases; in the others it was found at laparotomy for intra-abdominal abscesses. Gangrenous cholecystitis was found in two of the cases. Three of the patients recovered; one died from his other injuries.

The time interval between initial injury and cholecystitis was from three to five weeks. In all cases the cholecystitis was seen at or after laparotomy for complications of previous abdominal surgery.

All cases were either receiving IV fluids or had recently begun limited oral intake. Literature review shows males to predominate in a two to one ratio in this disease and over 50% of the cases at over 60 years of age. The age span in our cases was 19 to 29; all were males.

Absence of stones occurs in only five to ten percent of cases of classical cholecystitis, but in postoperative cholecystitis the absence of stones ranges from 31 to 53 percent. None of our four cases had calculi in the gall bladder.

Infection does not appear to be the cause of the cholecystitis, but simply an increase in the concentration of bile salts in the gall bladder can result in inflammation--which is roughly proportional to the bile salts concentration. Biliary stasis is a feature of the fasting in the postop period when there is no reflex release of cholecystokinin. Opiates and narcotics cause increased intrabiliary pressure due to contraction of the sphincter of oddi.

An additional etiologic possibility noted in two of our cases was an unusually small cystic duct. Possibly these smaller than usual cystic ducts were unable to handle the thick, concentrated viscous bile of the postoperative period.

Since transient pain, fever and ileus are common after any abdominal operation, the development of this new surgical emergency may be hidden.

XII TRAUMATIC HEMATOBILIA

Thatcher Magoun,MAJ/USA, Surgery, Camp Zama ,Japan

Traumatic hemobilia is a rarely encountered entity. Sixty-four cases have been reported since 1960.

The condition results from a communication between a blood vessel and the biliary ductile system in a closed cavity. The intrahepatic cavity may result fror cavity may result from central rupture of the liver or sealed lacerations of the liver.

Traumatic hemobilia should be suspected in a patient with colicky abdominal pain, GI

hemorrhage and jaundice, and a history of liver trauma. The diagnosis is aided preoperatively by hepatic scintilloscan and selective angiography.

Hepatic resection is the preferred treatment.

XIII. INJURIES INVOLVING THE INTESTINE AND BONY PELVIS

John P. CHRISTY, MAJ MC USA, General Surgery, USA HOSPITAL CAMP ZAMA

Complications of missile tracts, especially those involving bone, by way of which visceral injuries have occurred, have received relatively little attention in civilian and military medical literature. In spite of nominal mention in the 1970 CINCPAC Bulletin, the occurrence, and relative frequency of septic complications of this type of injury has not changed in the past two and one-half to three years.

In a group of eighteen personally treated cases, examples of intra-abdominal abscess, extra-serousabscess, major arterial hemorrhage, intestinal obstructions, laceration of intestine by bone fragments, pyarthrosis of the hip and osteomyelitis were seen. Three case histories were presented in detail. Cases in which colon was injured, in which joint injury was not diagnosed and in which large metallic fragments were retained were especially prone to these complications.

The secondary missile effect of bone fragments should be emphasized. Debridement of bone, bone fragments and other foreign bodies must be vigorously pursued in patients in which bone and bowel injury are combined. In cases where hip joint injury is considered a possibility, joint exploration must be done if pyarthrosis is to be avoided.

XIV Preliminary Analysis of Mortality Experience with Hemodialysis Therapy During Wartime

Barry J. Rosenbaum,MAJ,USAF,MC, INTERNAL MEDICINE, TACHIKAWA,JAPAN

70 patients underwent hemodialysis over a four year period. 37(47%) of these were primarily medical cases; mortality was 10.8%. 42 (53%) were primarily post-traumatic surgical cases; mortality 50.0%. Mortality in the latter group was unrelated to frequency of dialysis as long as BUN remained below 100 mgm% and acid-base and electrolyte balance was maintained. Mortality in this group was directly related to site of wound and whether or not uncontrollable infection was present: post-traumatic chest and/or abdominal wounds with uncontrollable infection resulted in a 4+ mortality; chest and/or abdominal wounds with controlled infection, 3+ mortality; extremity wound with or without infection, 2+; post-elective surgical procedure,1+. These overall mortality data are comparable with those obtained during the latter part of the Korean War and early part of the Vietnam War. Therefore: a) Mortality in hemodialyzed post-traumatic renal failure patients has not changed appreciably through several conflicts. b) Mortality is directly related to wound severity and whether or not infection is present and able to be controlled. c) Mortality is unrelated to severity and cause of renal failure as long as azotemia, acid-base status, and fluid and electrolyte balance is controlled. Surgeons must treat the patient's wounds vigorously to minimize and control infection, and not be concerned with the complication of renal failure if controlled.

XV. Fever of Undetermined Origin in Severely Injured Patients.

D.M. Weber,CDR/USN,Internal Medicine, USNH Yokosuka,Japan

NO ABSTRACT SUBMITTED

XVI. Drug Abuse and War Surgery

Thomas F. Trott,CAPT/USAF,MC, PSYCHIATRY, USAF HOSPITAL TACHIKAWA,JAPAN

Drug abuse is becoming a major problem in medical and surgical patients in SEA. Any patient must be regarded as a potential drug abuser. An estimated 6% of patients reaching Yokota Air Base, Japan from SEA suffer from effects of drug withdrawal and/or addiction. The drugs commonly seen in withdrawal are heroin, often from smoking, amphetamines, cocaine and alcohol.

The drugs used vary with the locality. Most patients will readily admit which drugs they are taking when questioned.

Heroin and cocaine withdrawal symptoms consist of dilated light reactive pupils, elevated pulse, blood pressure,temperature and respiratory rates, muscle aches, nausea,vomiting, diarrhea, rhinorrhea, lacrimation,weakness, restlessness, yawning and sleep.

Treatment of heroin withdrawal consists of methadone 10-20 mg PO or IM initially followed by 40-60 mg PO in the first 24 hours. This is then reduced to zero over one week. Cocaine withdrawal is treated with Thorazine 25 mg IM immediately followed by 25-50 mg IM at 1 to 2 hour intervals until symptoms are relieved. Oral dosea may be subsituted at twice the IM dose. Doses of Thorazine over 100 mg IM or 400 mg PO per day should be covered with Artane or Cogentin 1-2 mg BID to prevent extrapyramidal reactions.

Occasionally durg use results in irrational behavior, the amphetamines being the worse offenders. Chronic amphetamine use results in a paranoid state and high IV doses may result in bizzare, wild and destructive behavior such as setting fire to ones self. Amphetamine intoxication is marked by dilated light reactive pupils, blood pressure elevation,tachycardia, hyperreflexia,sweating, confusion, paranoid ideation, irritability and aggressive behavior. Treatment is with Thorazine as outlined for cocaine.

Some patients are given Thorazine upon processing out of SEA to prevent heroin withdrawal. This should not be done because the patient may manifest both heroin withdrawal symptoms and extrapyramidal reactions from Thorazine. Coma may result from attempts to treat heroin withdrawal by self administration of locally purchased tranquilizers. Treatment consists of support of cardiovascular and respiratory functions. Gastric lavage should be performed as well.

In summary, think of the possibility of drug abuse, use or withdrawal in each patient evaluated no matter what the initial problem might be.